Timer-Counters

PM 6670...72

Service Manual

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850315 Second Edition

S&I

Scientific & Industrial Equipment Division

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Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

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Timer-Counters

PM 6670...72

Service Manual

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1. SAFETY REGULATIONS

General information

This counter has been designed and tested in accordance with IEC Publication 348, Safety Requirements For Electronic Measuring Apparatus For Class 1 Instruments, and has been supplied in a safe condition. The present manual contains information and warnings that shall be followed by the user, to ensure safe operation and to retain the counter in a safe condition.

Before connecting the counter to the line (mains), visually check the cabinet, controls, connectors, etc, to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect the counter to the line. All components on the primary side of the line transformer are CSA approved and should only be replaced with original parts.

In the event of obvious damage, missing parts or if the safety of the counter is suspected, a claim should be made to the carrier immediately. A PHILIPS Sales or Service organisation should also be notified in order to facilitate the repair of the counter.

Grounding

The counter is connected to ground via a three-core line cable, which must be plugged into a socket outlet with a protective ground contact. No other method of safety grounding is permitted for this counter. When the counter is brought from a cold to a warm environment, condensation may cause a hazardous condition. Therefore, ensure that the grounding requirements are strictly met.

Any interruption of the protective ground, inside or outside the counter is dangerous. Line extension cables must always have a protective ground conductor.

Opening of the cabinet

The counter shall be disconnected from all voltage sources before it is opened. If adjustment or maintenance of the counter with the covers removed is inevitable, it shall be carried out only by a qualified person, who is aware of the hazard involved. Bear in mind that capacitors inside the counter may still retain their charge, even if the counter is disconnected from all voltage sources.

Opening of the cabinet or removing of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals that can be dangerous to life.

Line voltage setting

Before connecting the counter to the line, ensure that it is set to the local line voltage. On delivery, the counter is set to either 115V or 220V, as indicated on the line voltage selector on the rear panel. If the voltage setting is incorrect, set the line voltage selector in accordance with the local voltage, before connecting the counter to the line.

Fuses

The counter is protected by a thermal fuse, located in the line transformer and a secondary fuse, 1.6A fast-blow (not PM 6670) on PCB U1. Remove the line plug before fitting a fuse. Ensure that only fuses of the specified type are used. If the counter is set for operation on 115V line voltage, but is connected to a 220V supply, the thermal fuse will blow immediately to protect the counter.

2. CIRCUIT DESCRIPTION

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2. CIRCUIT DESCRIPTION

Introduction

The PM 6670-series of counters are equipped with a microcomputer and a LSI counter-on-a-chip. The microcomputer reads the setting of the panel controls, calculates the result of the measurement and sends the value to the display. The LSI (OQ0040) does the actual counting, but before the signal to be measured reaches the logic circuits it is pulse shaped in the input amplifier. A simplified block diagram of PM 6670...72 is shown in Fig. 2.1. More detailed block diagrams can be found in Section 7 (Circuit diagrams).

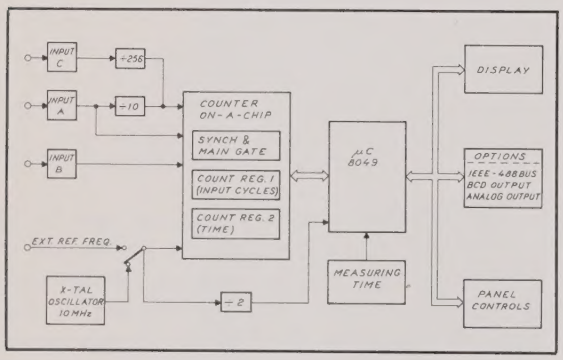


Fig. 2.1 Simplified block diagram.

The Microcomputer

The microcomputer (IC162) used in PM 6670...72 is an 8049 single-chip microcomputer with an 8-bit bi-directional data-bus and 16 static input/output ports. The internal memory consists of 128 byte RAM (read/write memory) and 2K byte ROM (Read-Only-Memory) for the program.

The microcomputer performs the following functions:

- reads the setting of the controls on the front panel;
- sends control information to OQ0040 and other logic circuits;
- reads the decade counting registers in OQ0040 after the measurement;
- calculates and sends the result to the display with correct resolution.

The program flow-chart is shown in Fig. 2.3.

OQ0040 Counter-on-a-chip

The OQ0040 (IC161) is an in-house developed LSI counter-on-a-chip. It contains two 9-decade counting registers and an input synchronizing and timing control block. Its purpose is to:

- connect input A, input B, CARRY and CLK to the correct decade counting register;
- synchronize the start/stop of a measurement after receiving start/stop requests from the microcomputer;
- act as a main gate;
- inform the microcomputer when a measurement has started and stopped.

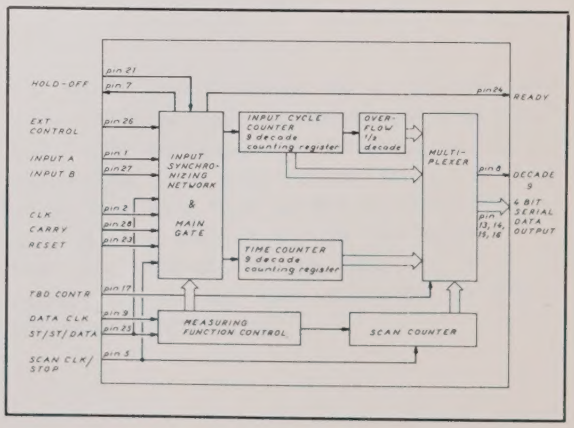


Fig. 2.2 Block diagram of OQ0040.

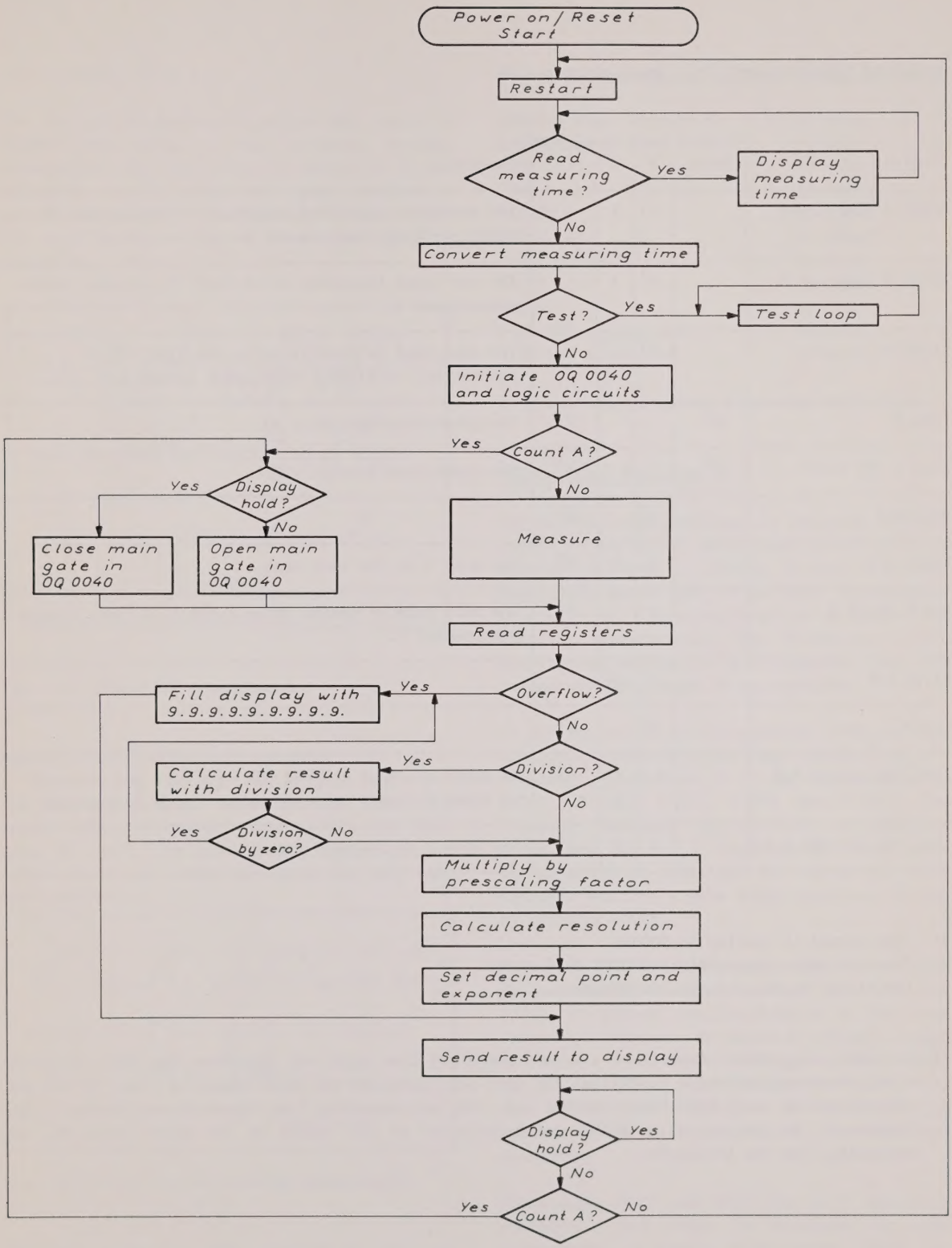


Fig. 2.3 The program flow-chart.

Measuring functions and their input signals

Function	Signals used in OQ0040 Carry	A	B	CLK	Comment
COUNT A start/stop by B		X[1]	X		The main gate opens and closes after two events at input B. Single measurement *.
COUNT A gated by B		X[1]	X		The main gate is opened while input B is high. Single measurement *.
COUNT A manual		X[1]			The main gate is controlled by the DISPL HOLD pushbutton. ST/ST/DATA high means closed main gate.
FREQ A	X[2]			X[1]	The prescaling factor is 10.
FREQ C (PM 6672)	X[2]			X[1]	The prescaling factor is 256.
PERIOD A		X[2]		X[1]	
PHASE A/B		X	X	X[1]	See Note 1 on the next page
PULSE WIDTH A		X		X[1]	The main gate is opened while input A is high. Single measurement *.
RATIO A/B		X[1]	X[2]		
RPM A		X[2]		X[1]	
TIME INT single A-B		X	X	X[1]	An event at input A opens the main gate and an event at input B closes the main gate. Single measurement *.
TIME INT average A-B		X	X	X[1]	See Note 2 on the next page

1) This signal is counted in OQ0040.
2) The main gate is synchronized with this signal.
The signal is also counted in OQ0040.

*) A single measurement means that the set measuring time does not influence the real measuring time. The synchronization conditions for open main gate set the real measuring time. If the set measuring time is longer than the real one, the set measuring time functions as display time. Reading of the registers in OQ0040 and calculation of the result do not start until the set measuring time has terminated.

Note 1 (Phase A/B):

The counting is controlled by two Main Gates in OQ0040. One makes a Time Interval Average measurement. The main gate is opened by A and closed by B. The other main gate performs a period measurement, synchronized by signal B. The clock reference pulses are counted in both registers.

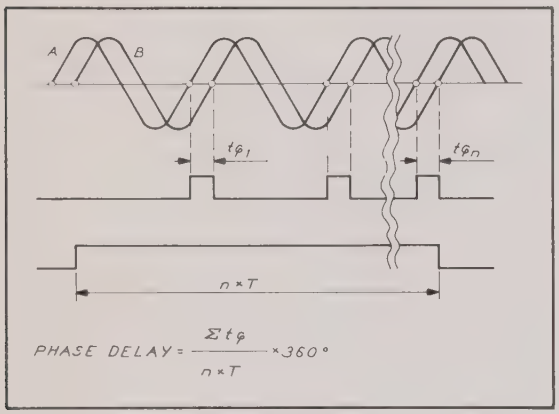


Fig. 2.4 Phase A/B measurement.

Note 2 (Time interval average A-B):

Two decade counting registers are used. One counts clock reference pulses while the main gate is open. The sums are accumulated. The other counts the number of times the main gate has been opened.

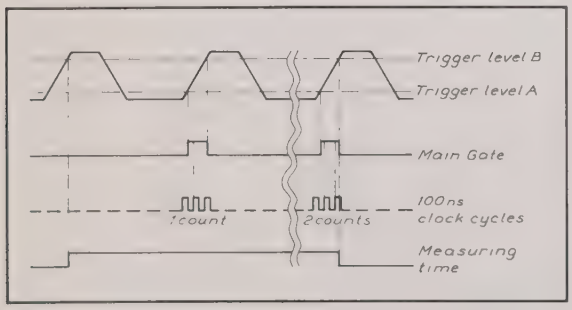


Fig. 2.5 Time Interval Average measurement.

The real measuring time depends on the set measuring time, synchronization time and internal delay in OQ0040. The following table gives approx. total measuring times for different measuring functions.

Measuring function	Total measuring time
COUNT A start/stop by B	MT+40ms
COUNT A gated by B	MT+40ms
FREQ A	MT+45ms
FREQ C	MT+140ms
PERIOD A	MT+45ms
PHASE A-B	MT+75ms
PULSE WIDTH A	MT+40ms
RATIO A/B	MT+45ms
RPM A	MT+50ms
TIME INT average A-B	MT+50ms
TIME INT single A-B	MT+40ms

MT = set measuring time + synchronization time

120MHz Input Amplifier

The 120MHz input amplifier is identical for all models PM 6670...72. Split band circuitry, with overlapping range 5...150kHz, is used to achieve high performance from DC to high frequencies. Channel A and B are identical for accurate time interval measurements. The following circuit description applies to both channels, but only components for channel A are mentioned.

By pulling switch SK113, capacitor C1001 is connected in series with the input signal, i.e. AC-coupling. Attenuation by 10 is accomplished by R1001, R1002, R1027, C1018 and C1003. The frequency response is adjusted by capacitor C1002, see Section 3 (Adjustments). When push-button SK107 is released, the signal is unattenuated and the 1 Mohm input impedance is set by resistor R1026.

Resistor R1004 limits the current. At high frequencies, R1004 is bypassed by R1003 and C1004, to prevent any degradation of the high frequency response. The maximum voltage allowed at input A and B is $260V_{rms}$ up to 440Hz, falling to $12V_{rms}$ for frequencies above 1MHz. The zenerdiodes GR101 and GR104 limit the voltage to ± 2.7V to protect the impedance converter.

Transistors TS101 and TS102 form an HF impedance converter. This stage is optimized for high frequencies, as signals below approx 150kHz run through IC101. The HF stage gain is 0.95. IC101, the LF stage, forms a voltage follower with high

input impedance and low output impedance. This stage is preceded by a voltage divider (R1007 and R1008) with an attenuation to match the HF stage, i.e. 0.95. Resistor R1029 is necessary to prevent DC shift. Resistor R1028 and capacitor C1019 compensate for frequency attenuation due to R1029 together with the input capacitance at IC101:3. Resistor R1012 prevents signals from the HF stage entering the output of IC101.

When SK109 is pushed, IC101:6 is connected to ground via R1012 and C1010, forming a low-pass filter with a cut-off frequency of 50kHz. At the same time, the HF stage is grounded to prevent crosstalk.

At IC102:7, the HF and LF signals are summed. IC102 is a fast amplifier/comparator with Schmitt trigger and hysteresis control. In AC-mode, normally used for frequency measurements, potentiometer R1018 adjusts the hysteresis band (sensitivity) via IC102:4. In DC-mode, normally used for time interval measurements, R1018 adjusts the trigger level. In this case, the hysteresis band is set to a minimum. The minimum hysteresis band is set via R1061 to approx 15mV; see Section 3 (Adjustments).

Transistors TS103 and TS104 convert the signal levels from negative to positive ECL levels, i.e. from -1.8...-0.8V to +3.2...+4.2V.

When switch SK110 is pushed, i.e. COM mode, the input B comparator is connected to channel A. The advantages of having this switch after the input circuit are less crosstalk, no increase of input capacitance, no decrease of input resistance and possibilities to use the low-pass filter.

Trigger Indicator (PM 6671...72)

The output from the 120MHz input amplifier, is connected to a LED on the front panel via a trigger indicator circuit. The line receiver IC401 is configured as a comparator. Pin 11 of IC401 sets the reference voltage, V_{bb}=-1.3V. When the voltage at IC401:5 is lower than the voltage at IC401:4, transistor TS401 is turned off, i.e. the trigger indicator LED is turned on, indicating that the trigger level is set too high and vice versa. When the input amplifier triggers correctly, transistor TS401 is turned on and off, i.e. the LED blinks. The LED is lit during a time set by resistor R401 and capacitor C404.

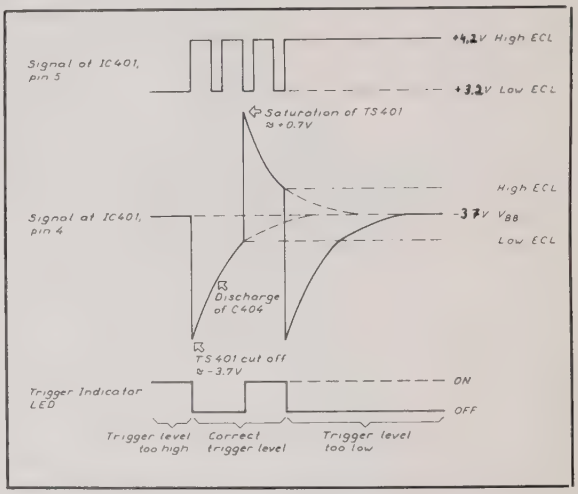


Fig. 2.6 Trigger indicator timing diagram.

Input D Amplifier

This Schmitt trigger/amplifier is an AC-coupled input for external reference (or for ratio measurement). The output is a positive ECL signal, as shown in Fig. 2.7.

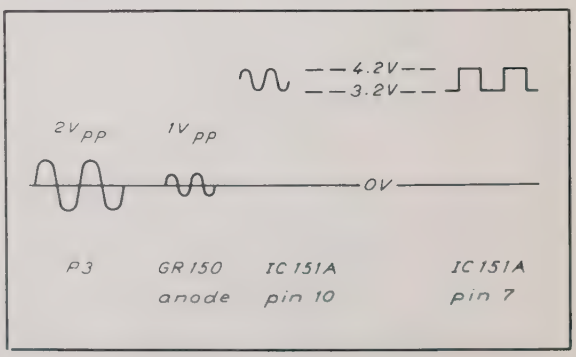


Fig. 2.7 A 100kHz sine-wave with $2V_{pp}$ amplitude, connected to Input D.

The Oscillator

The crystal KT151 is connected in the feedback loop of IC151B. The circuit oscillates with a frequency of 10MHz. The resistor R1157 increases the output impedance of IC151B and makes the oscillator more stable. Internal or external reference (clock signal) can be selected with switch SK114 on the rear panel. Even if an external reference is used, the internal reference is still used as a clock signal to the microcomputer. When an optional oscillator is installed in the counter, the crystal KT151 must be removed. IC151B will then be used as an amplifier. IC151C is a buffer amplifier between the oscillator and the logic circuits. Output pins 14 and 15 of IC151C give two complementary ECL signals, which are converted to TTL signals in the differential amplifier TS151 and TS152. The TTL signal is available at INT STD OUT on the rear panel. This output can be used as an external input signal to another counter. The 10MHz clock signal is divided by two in IC152A to provide a 5MHz clock signal for the microcomputer. The 5MHz signal is also divided by two in IC152B to provide a 2.5MHz clock signal for the optional Bus Interface PM 9696 via BU101:9.

Measuring Time

IC153 is used as an astable multivibrator, with the MEASURING TIME potentiometer controlling the frequency. The output from IC153 pin 3, see Fig. 2.8, is connected to the microcomputer input T1. The pulse duration is measured and converted to a measuring time, which can be varied in 33 steps per decade between 10ms...96s.

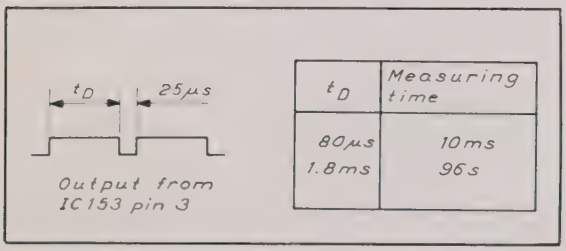


Fig. 2.8 The pulse duration is converted to a measuring time in the microcomputer.

The space between pulses is set by R1167 and C1156. The pulse duration is set by R1166, R1167, C1156 and the MEASURING TIME potentiometer R1 on the front panel. Potentiometer R1164 is used for adjusting the max pulse duration to 1.8ms.

If the jumper DV101 (TEST) is removed, the counter is set to the self-test mode; see Section 4 (Self-test).

Hold-off (PM 6671 only)

During the set hold-off time, the counter ignores re-triggering (channel A) or stop triggering (channel B). IC153 is configured as a monostable flip-flop. It is triggered by a pulse from OQ0040 pin 7. The hold-off time, i.e. the time until the flip-flop is reset, is set by R2, R1138 and C1130. The minimum hold-off time is adjusted by R1148; see Section 3 (Adjustments).

Microcomputer - OQ0040 Communication

The signals from the input amplifiers are connected to an ECL network (IC130 and IC131), controlled by the SLOPE pushbuttons. The channel A signal is connected to OQ0040 input A (pin 1) and, after division by 10 in IC160, to the CARRY input of OQ0040 (pin 28). The channel B signal is connected to OQ0040 input B (pin 27) and the clock reference signal is connected to the CLK input of OQ0040 (pin 2). For time and ratio measurements, the signal is connected to pin 1 (A) and pin 27 (B). If the CHECK pushbutton is pushed, the signals from the input amplifiers are disconnected from OQ0040. Instead, the 10MHz clock reference is connected to both input A and B of OQ0040.

When IC162:30 is at logic low, the C channel (PM 6672 only) is connected to the CARRY input of OQ0040 via IC132. When IC162:30 is at logic high, the input C signal is disconnected. If the CHECK pushbutton is pushed while input C is selected, the 10MHz clock reference signal is connected to the CARRY input of OQ0040 via IC160.

Before a measurement, the microcomputer resets the registers in OQ0040 by setting pin 23 (RESET) high and makes OQ0040 ready by sending 39 information bits. The information is sent in serial format to ST/ST/DATA, one bit for each positive-going slope of DATA CLK; see Fig. 2.9.

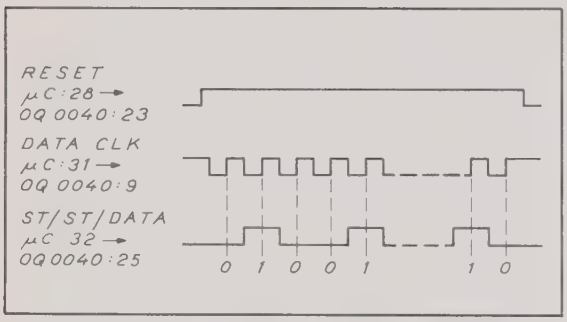


Fig. 2.9 The microcomputer sends information needed to make OQ0040 ready for a measurement.

When pin 28 of the microcomputer goes low again, the measurement starts as soon as the synchronization conditions are met. With EXT CONTROL it is possible to delay the start until a positive pulse is received at EXT CONTROL. OQ0040 pin 24 (READY) goes low and the microcomputer acknowledges by setting ST/ST/DATA high. The microcomputer then starts to count down the set measuring time. During the actual measurement the microcomputer and OQ0040 do not communicate.

When the set measuring time has elapsed, the microcomputer sets SCAN CLK/STOP low. OQ0040 terminates the measurement when the synchronization conditions are met and sets READY high. The contents in the 18 decade counting registers in OQ0040, are then sent in BCD format to the microcomputer from $A_{out}...D_{out}$. The microcomputer reads one decade at a time and steps to the next decade by sending clock pulses to SCAN CLK/STOP. To read a digit, TBD CONTR is set high. To find out which decade is read, the microcomputer sends clock pulses to SCAN CLK/STOP until DECADE 9 (pin 8) goes high. This indicates that the position is decade 9. The microcomputer starts reading; see Fig. 2.10. When all 18 decade counting registers have been read, the microcomputer calculates the result and sends it to the display. It resets OQ0040 and a new measurement can start.

The function COUNT A Manual is initiated by releasing DISPL HOLD and terminated by pushing DISPL HOLD. The pushbutton DISPL HOLD controls the signal ST/ST/DATA, which controls the main gate in OQ0040. ST/ST/DATA is low for an open main gate, i.e. pulses are counted.

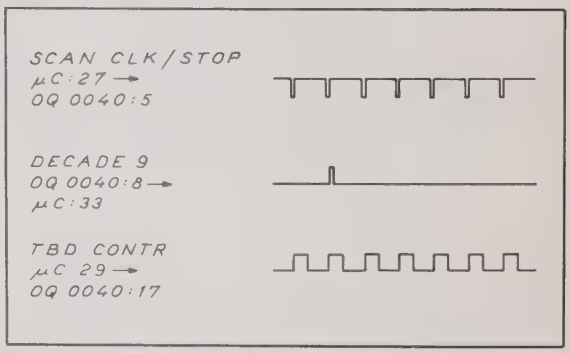


Fig. 2.10 A new digit is read after each pulse to SCAN CLK/STOP when TBD CONTR is high.

Example:

Function selector setting:

- select PERIOD A and push CHECK
- set measuring time to 10ms
- set the input E switch to EXT RESET
- do not use hold-off (PM 6671)

A suitable trigger signal for an oscilloscope is available on OQ0040 pin 23 (RESET).

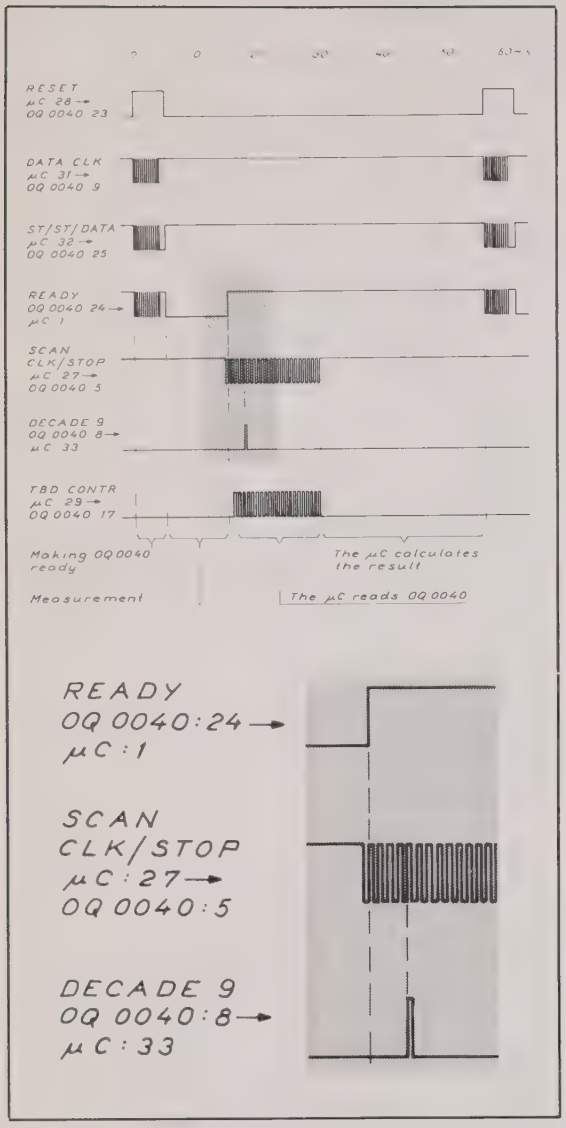


Fig. 2.11 Timing diagrams for microcomputer and OQ0040 communication.

Microcomputer - Display - Function Selector Communication

The display, decimal points, unit indicator and function selector are scanned by the microcomputer. During each scanning cycle the microcomputer sends out the measured result and reads the setting of the function selector. Each digit is sequentially turned on for 0.5ms. The measurement can be sent both to the display and an installed option via connector BU101. The microcomputer pin 38 (P27) controls the information flow.

P27 low: the display and function selector is addressed
P27 high: the installed option is addressed

The bidirectional data bus DB0...DB7 on the microcomputer is used for sending information to the display and receiving information from the function selector. The microcomputer pin 8 (RD) and pin 10 (WR) control this information flow.

WR pos flank: information is sent to the display
RD pos flank: information is received from the function selector

Four bits, DB4...DB7, are used for sending (in BCD format) the digits to be displayed. Each digit in the display shows its specific value for a period of 0.5ms. The digit's value is latched and decoded to a seven-segment format in the segment decoder/driver (IC201). The remaining four bits, DB0...DB3, are used for addressing the digit to be displayed. This address is sent in BCD format. The address is latched in the address latch (IC164) and decoded in the digit decoder (IC165). Only one of the outputs in the digit decoder is high at a time. This high signal, opens the corresponding digit driver for 0.5ms. At the same time, the digit's value is sent from the segment decoder/driver. During the following 0.5ms, the next digit is turned on, and so on.

The current through a LED display flows from the +5V supply through the digit driver transistor, the lighted segments and then to earth via the segment decoder/driver. All digits have a decimal point. Digit drivers 1...6 also have a unit indicator LED connected. Signal lines P24 (pin 35) and P25 (pin 36) of the microcomputer control them.

P24 low: a decimal point is lit
P25 low: a unit indicator LED is lit

The microcomputer blanks leading zeros by setting P26 (pin 37) low. This blanking signal is also used for the fail safe circuit. If the microcomputer stops, one digit might remain lit and could be degraded after a couple of minutes. If P26 (pin 37) stays high, C1160 will be charged to +5V. This results in a reset signal to the address latch. All outputs go low. The digit decoder sets output pin 3 high. Pin 3 is not connected to any digit driver so all digits will be turned off.

The output from the digit decoder is also used for reading the setting of the function selector. When a digit is lit, the microcomputer reads the setting. This is achieved by the RD output (IC162:23) going low, which opens the tri-state buffer IC163. The function selector setting information is now available on the bi-directional data-bus (DB0... DB3) to the microcomputer.

The logic states are as follows:

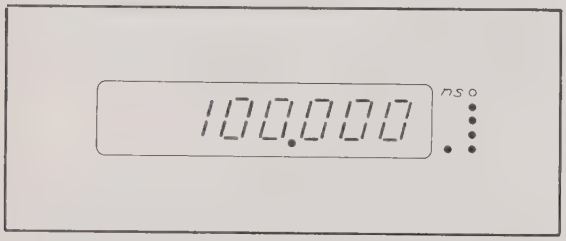
Closed switch: logic high level
Open switch: logic low level

Example:

Function selector setting:

- select PERIOD A
- push CHECK and DISPL HOLD
- set measuring time to 10ms
- set input E switch to EXT RESET

The display will show:



A suitable trigger signal for an oscilloscope is available on IC165 pin 9. Timing diagrams are shown in Fig. 2.12 and 2.13.

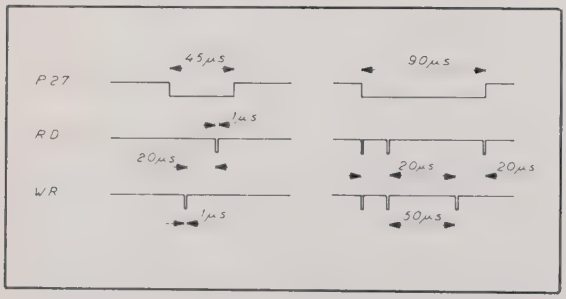


Fig. 2.12 Details of the P27 signal together with the Read and Write signal from the microcomputer.

The Power Supply

PM 6671 and PM 6672 can be connected to

- $115V_{AC}$ or $230V_{AC}$ ±10%, 45...440Hz
- $11.8...28V_{DC}$
- The optional battery pack PM 9693 ($12V_{DC}$)

Note: PM 6670 is equipped with a power supply where the regulation is provided by two integrated circuits. It is not possible to connect PM 6670 to an external DC supply or an internal battery pack.

The output from all power supplies is regulated +5V and -5V.

All three counters are protected by a thermal fuse VL101 located in the line transformer. PM 6671 and PM 6672 also have a secondary fuse VL102 (1.6A fast-blow) on PCB U1. At VL102 the voltage is approx. $25V_{DC}$ in a PM 6671/01 connected to $220V_{AC}$.

The POWER ON/OFF switch SK101 on the front panel is a secondary switch, which has no effect on the voltage supply to the optional oven stabilized oscillator.

The following description applies to PM 6671 and PM 6672.

In position POWER ON, the voltage is supplied to IC180 via the transistor TS184 and diode GR186, which form a voltage limiter. The voltage is limited to approx. $15V_{DC}$. IC180 is specially designed for applications in switched-mode power supplies. The output control signal (pin 14) is connected to the switch transistor TS182. This pulse train has constant amplitude and frequency, but a pulse duration that is dependent on the load. The frequency (40kHz approx.) is set by resistor R1197 and capacitor C1192. The control loop senses the +5V output via R1187...1189, as shown in Fig. 2.13. The +5V output is adjustable with potentiometer R1188.

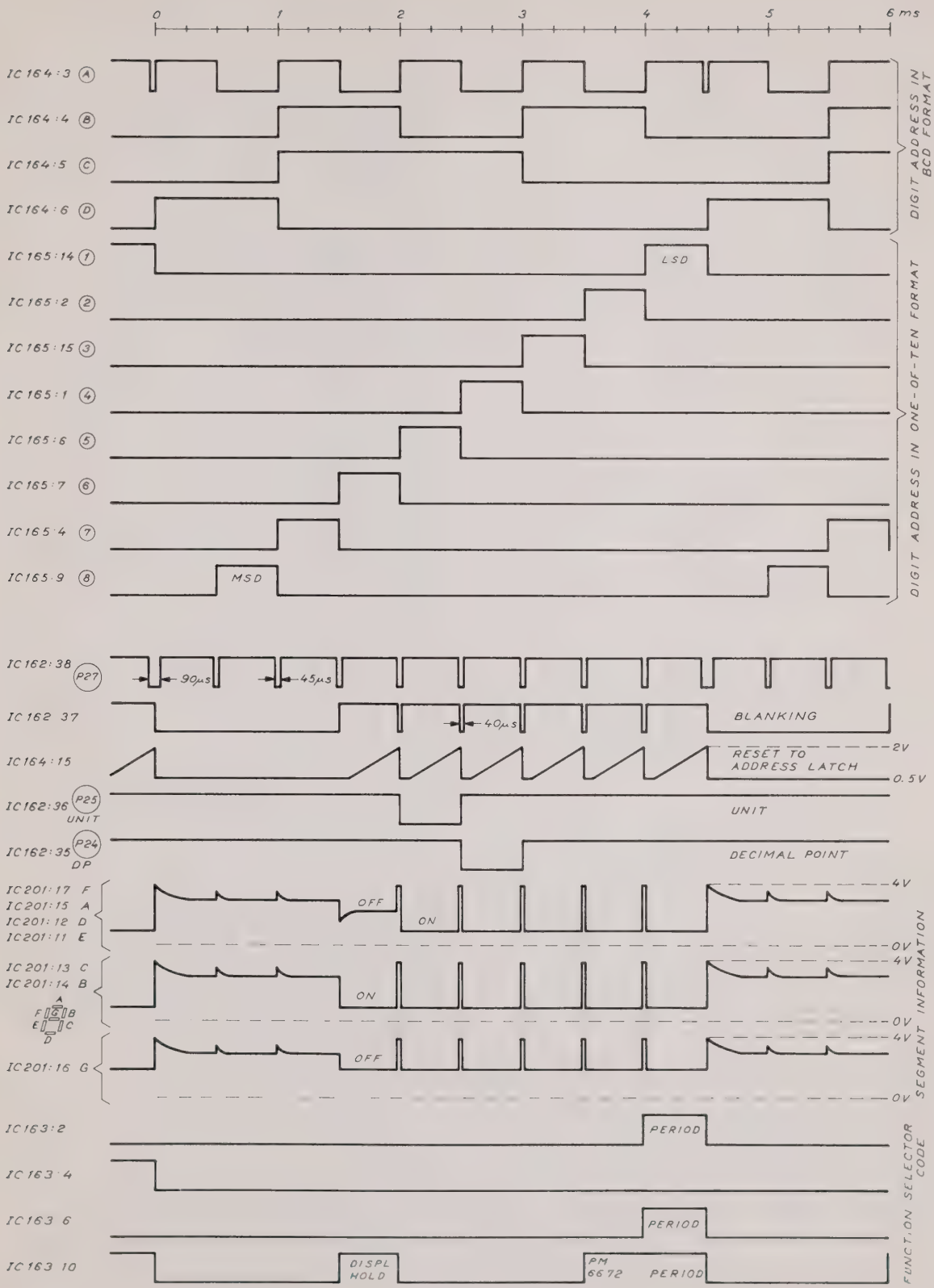


Fig. 2.13 Timing diagrams for Microcomputer - Display - Function Selector communication. Applicable to the example on the previous page.

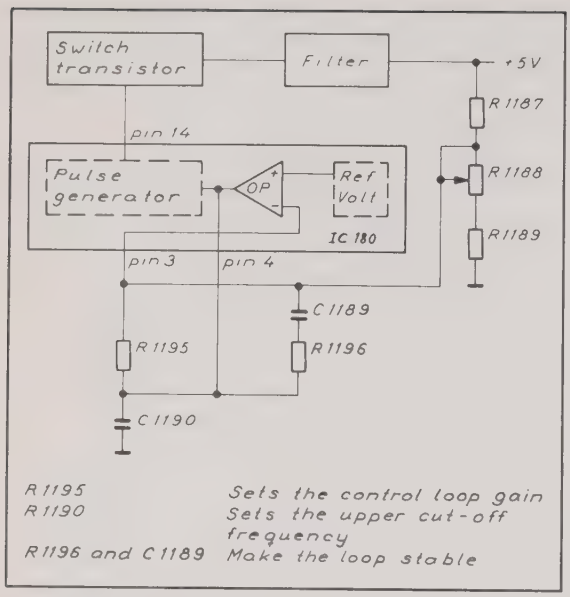


Fig. 2.14 IC180 and the control loop.

The amplifier output (IC180:4) is 4V for 12V input and 2V for 30V input. The output is 8.5V when the power supply is not regulating. This 8.5V is used to reset the microcomputer at POWER ON and at line (mains) failures of short duration.

The output from the OP amplifier controls the pulse duration to the switch transistor TS182. When TS182 is conducting, magnetic energy is stored in the transformer T102. When TS182 stops conducting, the magnetic energy is discharged via the diode GR183. Some of the magnetic energy is discharged via the secondary winding of T102. The unregulated voltage is rectified by the diode GR184 and regulated by IC181 to -5V.

When the current increases, the voltage across resistor R1182 increases, and at a current through R1182 of approx 2A, transistor TS181 starts conducting. When the voltage at IC180:11 exceeds 0.5V, the pulse duration decreases to avoid current surge. The diode GR185 gives overvoltage protection.

When the optional internal battery pack PM 9693 is installed, the voltage on pin BU104:7 is used for charging the battery. BU104:7 is connected to BU104:6 via a jumper when PM 9693 is not installed.

1GHz Prescaler (PM 6672)

The 1GHz prescaler for PM 6672 is AC-coupled and divides the frequency of the input C signal by 256.

Capacitor C301 blocks any DC component on the input signal. To prevent latching of IC301, the diode GR306 clamps the negative half period of the input signal to 2.7V.

The network R301...R303 and GR301...GR303 forms a PIN diode attenuator and provides the required input impedance. The PIN diodes GR302/303 and resistor R302 form a variable attenuator, controlled by the amplitude of the input signal. The current through R301...R303 and the Schottky diode GR301 makes the PIN diode reversed biased with a bias voltage of approx 0.65V. The PIN diode attenuator is not activated for input signals with low amplitude. If the input amplitude increases to a level that makes GR301 rectify, the DC level of the input signal will decrease, as the positive voltage is then limited. The PIN diodes GR302/303 will start conducting when the DC level has decreased from +0.5V to -0.65V. A PIN diode has a current controlled variable impedance. An increased input amplitude increases the current through the PIN diode, thus giving it lower impedance, i.e. higher attenuation in the attenuator R302 and GR302/303. The result is an almost constant amplitude at IC301:3 when the PIN diode attenuator is activated.

In IC302, the frequency is divided by 256. To prevent errors due to insufficient amplitude, the amplitude of the input signal to IC302 is monitored. The detector diode is GR304 and the bias current through this diode is provided by R314 and R315. In the Schmitt trigger (IC303 and R319), the detector voltage is compared with a reference voltage set by potentiometer R317. If the detector voltage is lower than the reference voltage, transistor TS302 is turned on, i.e. IC302:10 is connected to ground. This means that the signal passes through IC302. If the detector voltage exceeds the reference voltage, TS302 is turned off and IC302 is disabled.

The RC network R308...R313 and C306...C312 is needed to achieve a flat frequency response. Diode GR307 is used for temperature compensation of GR304. The output signal from IC302 is buffered and converted to ECL levels by transistor TS303.

3. ADJUSTMENTS

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- Warnings 3-2
- Required Test Equipment 3-2
- Initial Set-up 3-2
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- Measuring Time 3-3
- Hold-off 3-3
- DC Balance 3-3
- Hysteresis 3-4
- Frequency Compensation 3-4
- RF Enable 3-4
- Frequency Adjustment of the Standard Oscillator ... 3-4

3. ADJUSTMENTS

Warnings

This section contains information which must be followed to ensure safe operation and to retain the counter in a safe condition. The instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any adjustments other than those specified in the instructions unless you are fully qualified to do so.

Opening of the cabinet exposes live parts which can be dangerous to life. Bear in mind that capacitors inside the counter can hold their charge even if the counter has been separated from all voltage sources.

Required Test Equipment

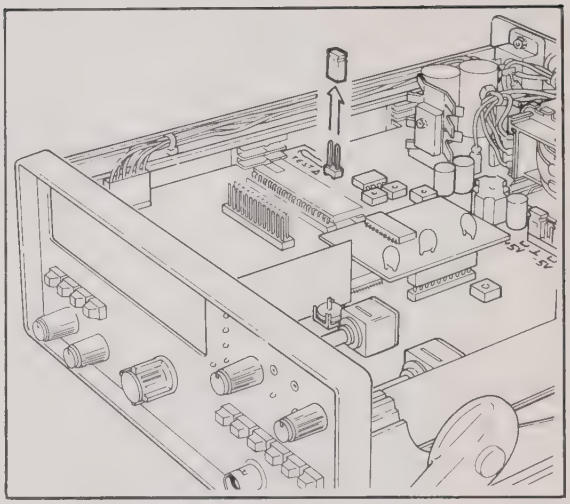
- DMM, e.g. Philips PM 2517
- Frequency counter, e.g. Philips PM 6673/02
- Oscilloscope, e.g. Philips PM 3215
- Function generator, e.g. Philips PM 5131
- HF signal generator, e.g. Wavetek 2002A
- Probe, 10 Mohm, 120MHz
- Termination, 50 ohm, BNC-type

Initial Set-up

All pushbuttons should be in a released position. Set MEASURING TIME to 10ms (fully anticlockwise) and HOLD OFF (PM 6671) to 0 (off). Pull both SENSITIVITY / TRIGGER LEVEL potentiometers and turn them fully clockwise. Select FREQ A. The slide switches on the rear panel should be set to INT STD and EXT RESET (not applicable to PM 6670). Set the line voltage slide switch on the rear panel to the local line voltage. Connect the counter to the line and press POWER ON.

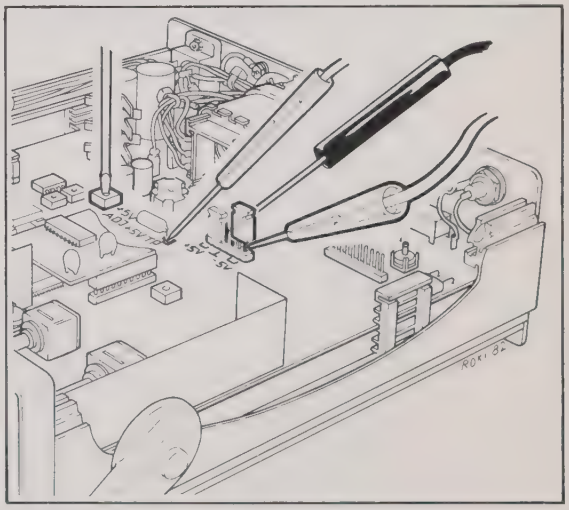
DC Voltage

- Remove the jumper TEST.



- Press RESET. The display read-out should be:
  00000071

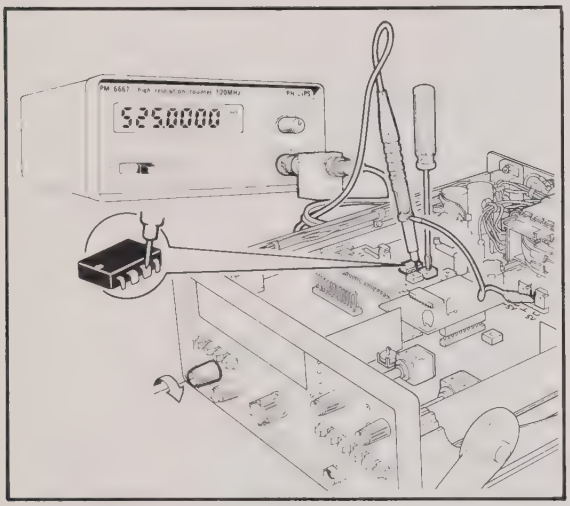
- Connect a voltmeter between +5V TP and ground.



- Adjust the potentiometer +5V ADJ (R1188) to 5.00 ± 0.05V. It is not possible to adjust the voltage in PM 6670. Just check that the voltage is 5.00 ± 0.25V.

Measuring Time

- Select COUNT A MANUAL and press RESET. The display read-out should be 0.
- Push the MEASURING TIME knob and adjust the potentiometer MEASURING TIME ADJ (R1164) to 0.010 on the display. The unit indicator LED s/GHz should light.
- Connect a frequency counter via a probe to IC153:3.
- Turn MEASURING TIME fully clockwise.
- Adjust R1164 so the testing counter measures 525...530Hz.



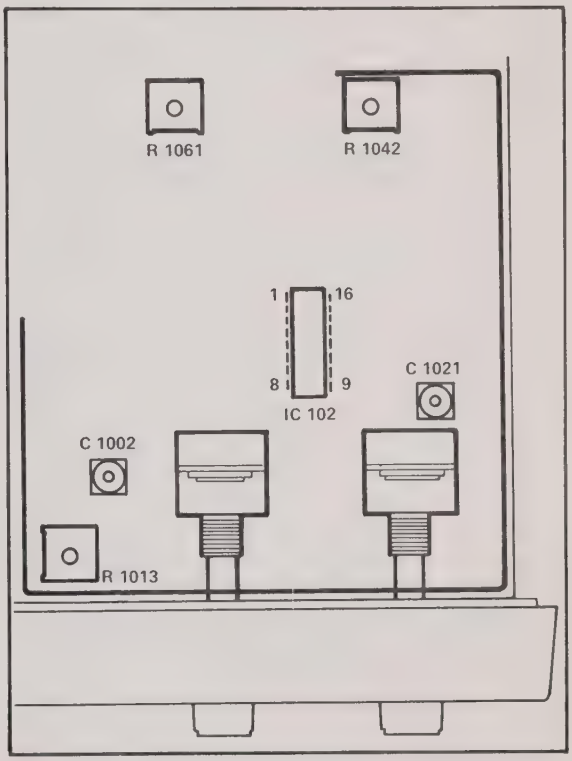
- Push MEASURING TIME and check that the display shows 96. The s/GHz LED should light. Turn MEASURING TIME slightly anti-clockwise. The display read-out should be 88. Reset MEASURING TIME to 10ms (fully anti-clockwise).

Hold-off (PM 6671 only)

- Select TIME INT SINGLE A-B and press CHECK.
- Turn the HOLD OFF knob to the 0.2ms position. The LED indicator should now light.
- Adjust the potentiometer HOLD OFF TIME ADJ (R1148) to 0.16ms on the display.
- Turn HOLD OFF fully clockwise (200ms).
- The display read-out should be at least 200ms. If not, adjust R1148 so the hold-off range 0.2...200ms is achieved.
- Reset HOLD OFF to 0 (off).

DC Balance

- Select FREQ A.
- Connect a 5kHz, 100mV$_{pp}$ sine-wave to input A. The counter should count correctly.
- Connect an oscilloscope to IC102:1 and adjust R1013 to 50% duty-factor.



- Decrease the amplitude of the input signal so the counter starts to count incorrectly.
- Adjust R1013 to a 50% duty-factor.
- Connect the signal to input B and repeat the procedure. Connect the oscilloscope to IC102:6 and adjust R1042.

Hysteresis

- Connect a 5kHz, 15mV$_{pp}$ sine-wave to input A.
- Adjust R1061 until the counter just starts to count correctly.
- This adjustment is common to input A and B.

Frequency Compensation

- Push both SENSITIVITY/TRIGGER LEVEL potentiometers. Check that they are still set fully clockwise.
- Connect a 5kHz square-wave via a 50 ohm termination to input A of the counter and channel A of an oscilloscope (500mV/div and 20us/div).
- Adjust the amplitude of the input signal and the time-base of the oscilloscope so that one period (4V$_{pp}$ 0.2ms) fills the screen of the oscilloscope.
- Connect channel B of the oscilloscope via a 10 Mohm probe to IC102:7. Set the oscilloscope to 50mV/div.
- Check that the amplitude at IC102:7 is at least 90% of the input signal amplitude (channel A).
- Press ATT x10 for input A and increase the sensitivity of the oscilloscope to 5mV/div.
- Adjust C1002 so the best pulse response is achieved. Check that the signal fills the screen.
- Connect the signal to input B and repeat the procedure. Connect the oscilloscope to IC102:10 and adjust C1021.
- Pull both SENSITIVITY/TRIGGER LEVEL and release the ATT x10 pushbuttons.

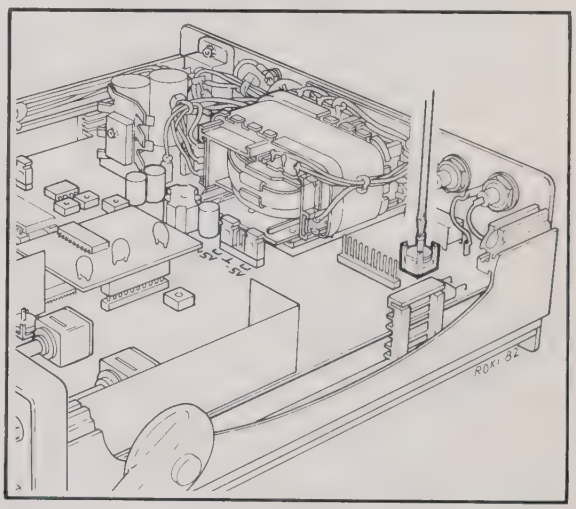
RF Enable (PM 6672 only)

- Press the input C pushbutton (1GHz).
- Connect a 70MHz, 15mV$_{RMS}$ signal to input C. Check that the counter measures correctly. If not, adjust R317 on the prescaler PCB.
- Repeat the procedure with 500MHz (15mV), 800MHz (15mV) and 1000MHz (25mV).
- Release the input C pushbutton.

Frequency Adjustment of the Standard Oscillator (/01 version)

This adjustment shall be performed at an ambient temperature of approx 23°C after a warm-up period of one hour.

- Select FREQ A.
- Connect a 10MHz reference signal with a tolerance of $1x10^{-6}$ to Input A.
- Set MEASURING TIME to 1s.
- Adjust trimmer C1154 with an isolated trimming screwdriver until the read-out on the display is 10000.000kHz ± 10Hz.



For /02.../05 versions, please refer to Section 9 (Optional Oscillators).

4. SELF-TEST

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- Introduction 4-2
- Initial set-up 4-2
- Self-test sequence 4-2

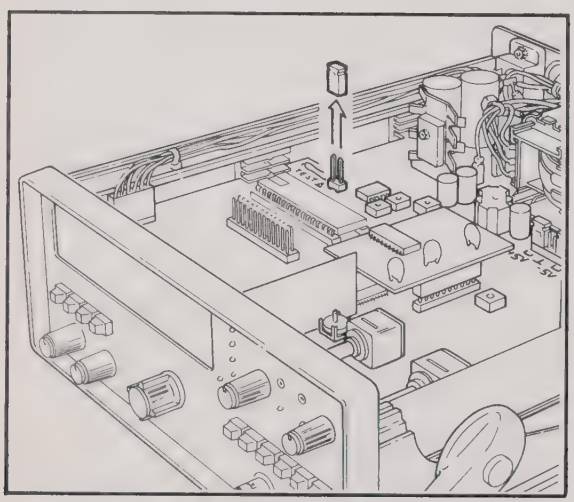
4. SELF-TEST

Introduction

The counters of the PM 6670...72 series, each have a built-in self-test facility, which complements the CHECK function available on the front panel. This facility provides a test of the communication between the microcomputer and the function selector switches on the front and rear panels, and also the communication between the microcomputer and the display.

Initial Set-up

All pushbuttons should be in a released position. Set MEASURING TIME to 10ms (fully anticlockwise) and HOLD OFF (PM 6671) to 0 (off). Pull both SENSITIVITY /TRIGGER LEVEL potentiometers and turn them fully clockwise. Select FREQ A. The slide switches on the rear panel should be set to INT STD and EXT RESET (not applicable to PM 6670). Set the line voltage slide switch on the rear panel to the local line voltage. Connect the counter to the line and press POWER ON.



- Remove the jumper TEST.
- Press the RESET pushbutton. The display read-out should be:

00000071

Self-test Sequence

If the digits in the display are labelled:

ABCDEFGH

the following read-out should be displayed for selected functions.

FREQ AVERAGE	B=1
ARMING or EXT RESET	B=0
DISPL HOLD pushed	C=1
pulled	C=0
MEASURING TIME pushed	D=1
pulled	D=0
HOLD OFF activated	F=1
not activated	F=0
COUNT A B	GH=40
COUNT A B	20
COUNT A MANUAL	11
PULSE WIDTH A	41
TIME INT SINGLE A-B	60
TIME INT AVERAGE A-B	31
PERIOD A	51
RPM A	61
FREQ A	71
RATIO A/B	70
PHASE A-B	30

Do not forget to install the jumper TEST.

5. TROUBLE-SHOOTING

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- The input amplifier 5-3
- The power supply 5-3

5. TROUBLE-SHOOTING

The following points will help trouble-shooting the PM 6670...72 series of counters.

- First check that the procedures in the Operating Manual (Section, Practical Measurements) have been followed. Take particulary notice of the slide switch settings on the rear panel.
- Check that +5V is present at the +5V test point and that -5V is present at BU110:1.
- Make the self-test as previously described. If the self-test gives an erroneous result for a particular function, check the corresponding circuit and switch for that function.
- If the self-test functions correct, the fault is probably in the input circuits or in OQ0040. IC160 and OQ0040 can be tested by the CHECK function.

For trouble-shooting, the ratio mode is sometimes better than the frequency mode because it is possible to use a low frequency signal.

- If the display makes no sense at all, check the microcomputer signal ALE (IC162:11) with an oscilloscope. The pulse width should be approx. 0.7us and the pulse space approx. 2.3us.
- If there is no ALE output, check that +5V is present at pin 26 and 40 of IC162. Measure to ground of the microcomputer (pin 20). Check that the oscillator signals at pin 2 and 3 of IC162 are correct, i.e. 5MHz. Replace the microcomputer if the oscillator signals are correct, but the ALE signal is not.
- If a correct ALE signal is present at pin 11 of the microcomputer, check the signals as illustrated in Fig. 5.1. It is difficult to get a steady display on an oscilloscope, so these figures are only a schematic illustration of the display.

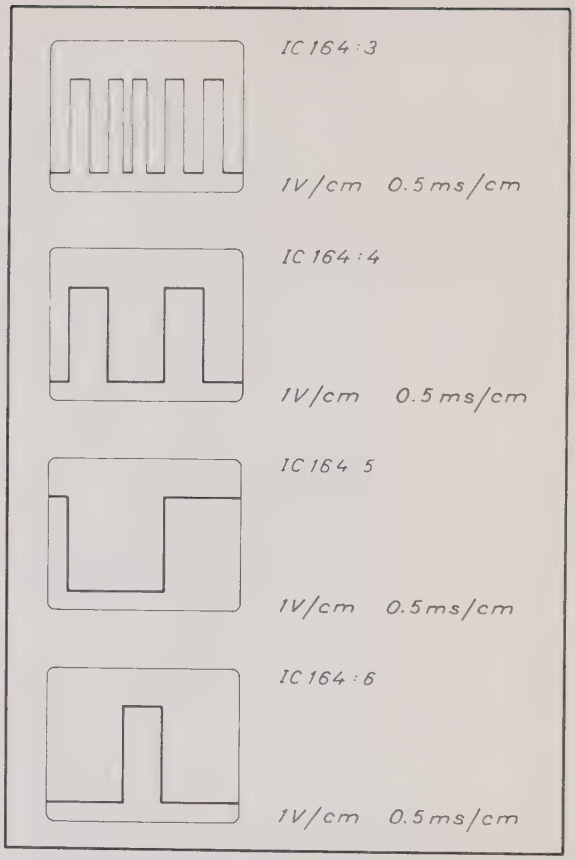

Fig. 5.1 If ALE is correct, check these signals.

Notes to Fig. 5.1:

- Trigg on IC165:1, negative slope, pulse duration = 0.5ms and pulse space = 3.8ms.
- At IC162:37, every 9:th pulse has longer duration.
- At IC162:38, every 9:th pulse has 90us duration.
- At IC162:8 and 10, every 9:th group of pulses consists of 3 pulses. The pulse duration is approx. 1us.

If the microcomputer signals are correct as illustrated in Fig 5.1, continue with checking IC164; see Fig. 5.2.

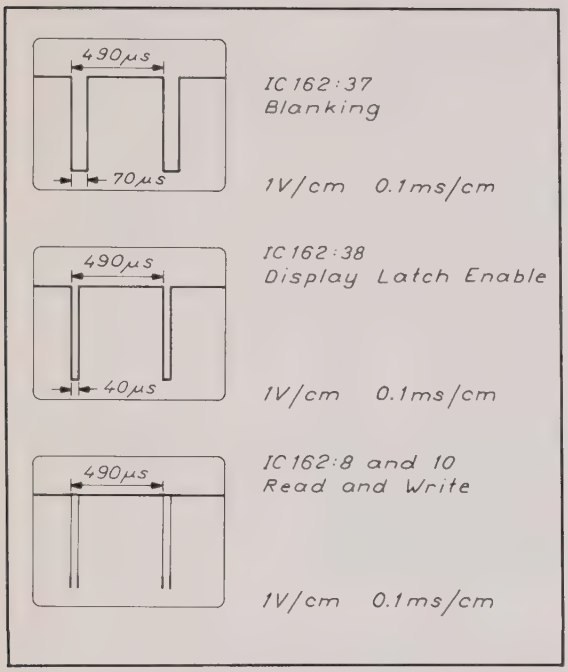

Fig. 5.2 Signals to check on IC164.

The Input Amplifier

Check the HF stage by first disconnecting this stage (push the 50kHz FILTER pushbutton) and connect a 10...15kHz square-wave signal to input A (or B). The signal at IC102:7 should look almost like a triangular-wave. By connecting the HF stage (release the 50kHz FILTER pushbutton) the signal at IC102:7 should be a square-wave again. The DC level at the emitter of TS102 should be approx. zero when the 50kHz FILTER pushbutton is pushed. DC drift due to temperature changes, might be caused by too high current leakage in diodes GR101...104. Distortion of the signal at IC102:7 might be caused by leakage in transistor TS101.

The power supply

A fault in the power supply can be isolated easier if the counter circuits are disconnected by removing the two jumpers on BU110. However, to simulate the load, a dummy load has to be used.

- Connect a 10 ohm, $>$ 2.5W resistor between BU110:1 and BU110:3.
- Connect a 47 ohm, $>$ 1.5W resistor between BU110:4 and BU110:6.
- The dummy load can be assembled by using a female connector, ordering number 5322 267 54102. Cut the connector to a suitable length.

6. REPLACING PARTS

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- Text plate and front rim 6-2
- Handle 6-2
- Power supply 6-2
- Replacing input amplifiers IC101 and IC103 ... 6-2

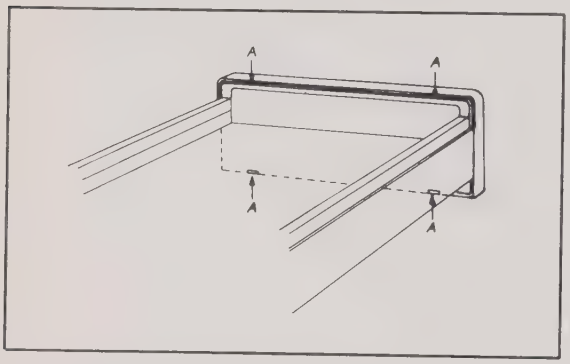
6. REPLACING PARTS

Molex contacts

- In the spare parts list, only a 13 pins contact is listed. However, the contact is easy to cut into required length.

Text plate and front rim

- Remove the knobs for measuring time and sensitivity.
- Put a screw driver between the front rim and the front frame at points A as shown below.



- Pry gently until the front rim comes off.
- Remove the text plate.

Handle

- Remove the two plastic knobs using a tiny screwdriver or a pair of pliers.
- Unscrew the two screws and pull out the handle.
- Before assembling, grease the lock washer, screw hole and teeth of the handle very slightly with vaselin.

Power supply

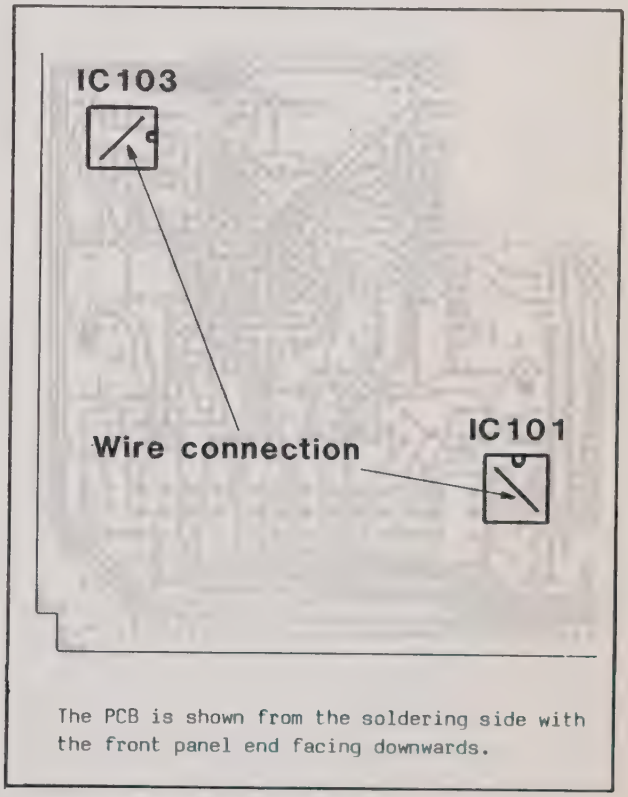
- When replacing parts in the power supply, in particular IC180, check the +5V voltage. Refer to Section 3 (Adjustments).

Replacing input amplifiers IC101 and IC103

The low frequency stage of the input amplifier is built around specially selected units of the CMOS operational amplifier CA3140E. This circuit has been replaced by the TLC271CP.

Modification

When replacing a CA3140E with a TLC271CP, one connection must be made between pins four and eight of each IC (IC101 and IC103). These connections are illustrated on the diagram below. To avoid short circuits, use insulated wire e.g. AWG 30 (0.25 mm).



The PCB is shown from the soldering side with the front panel end facing downwards.

7. CIRCUIT DIAGRAMS

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PM 6672
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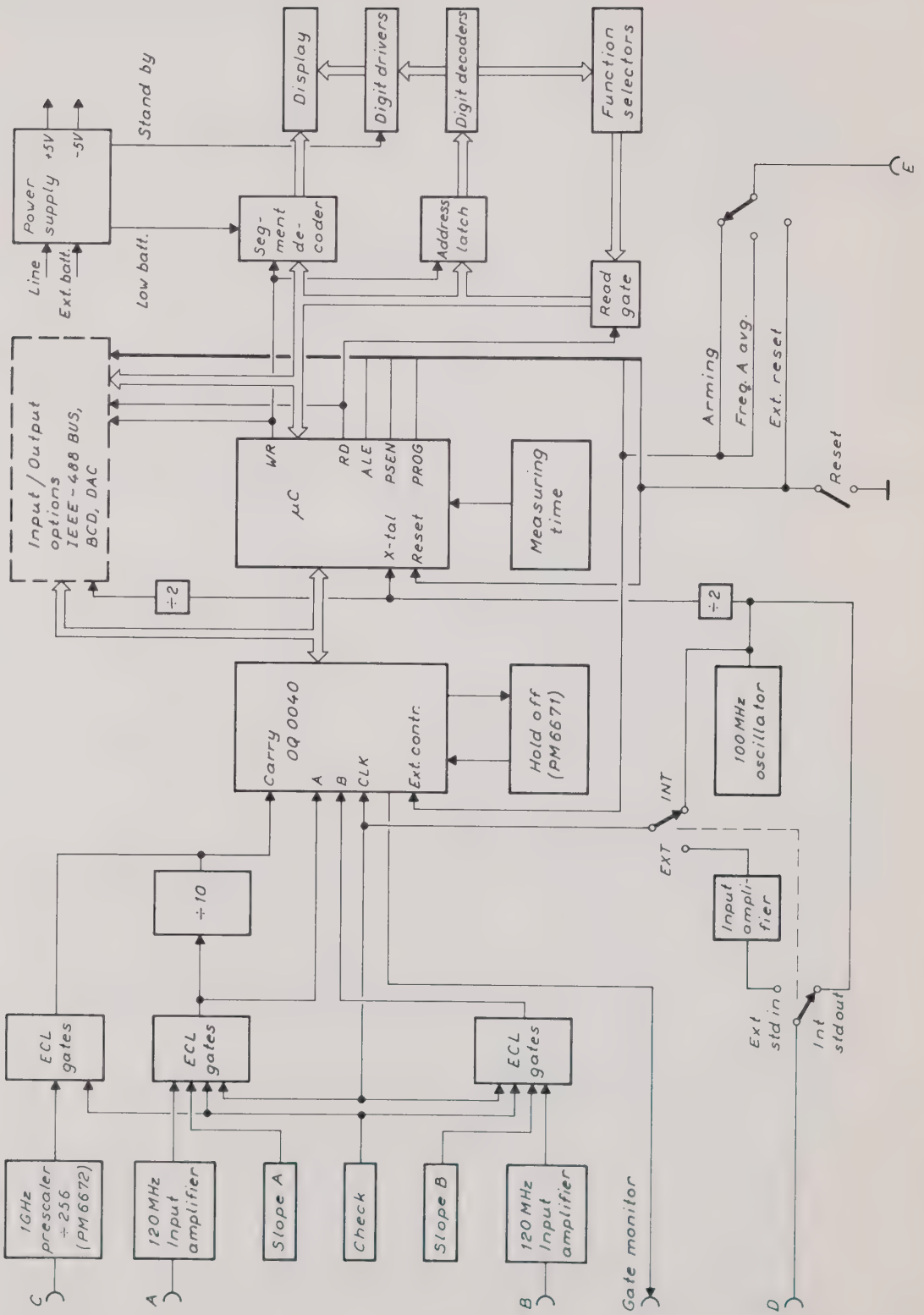
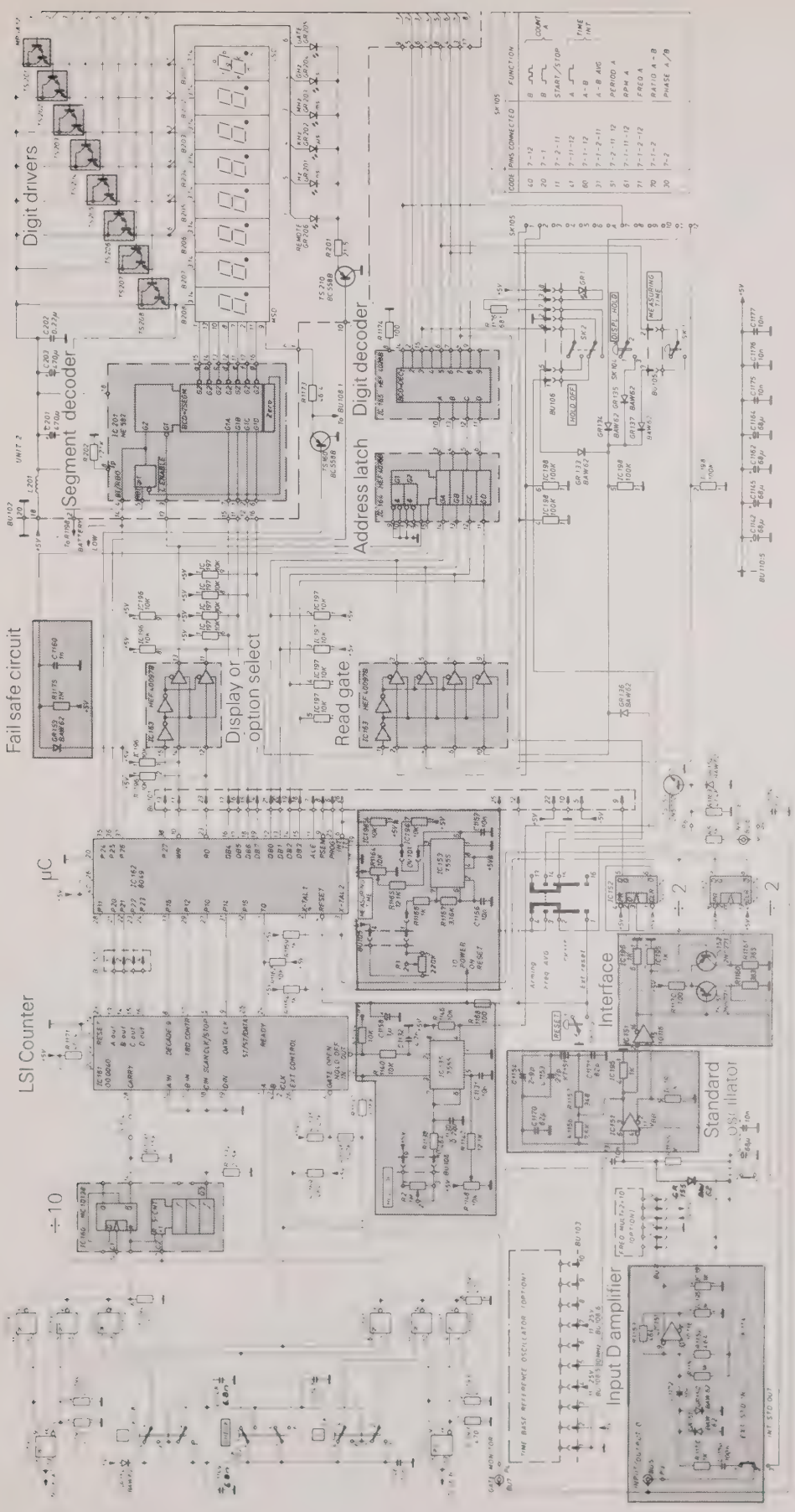
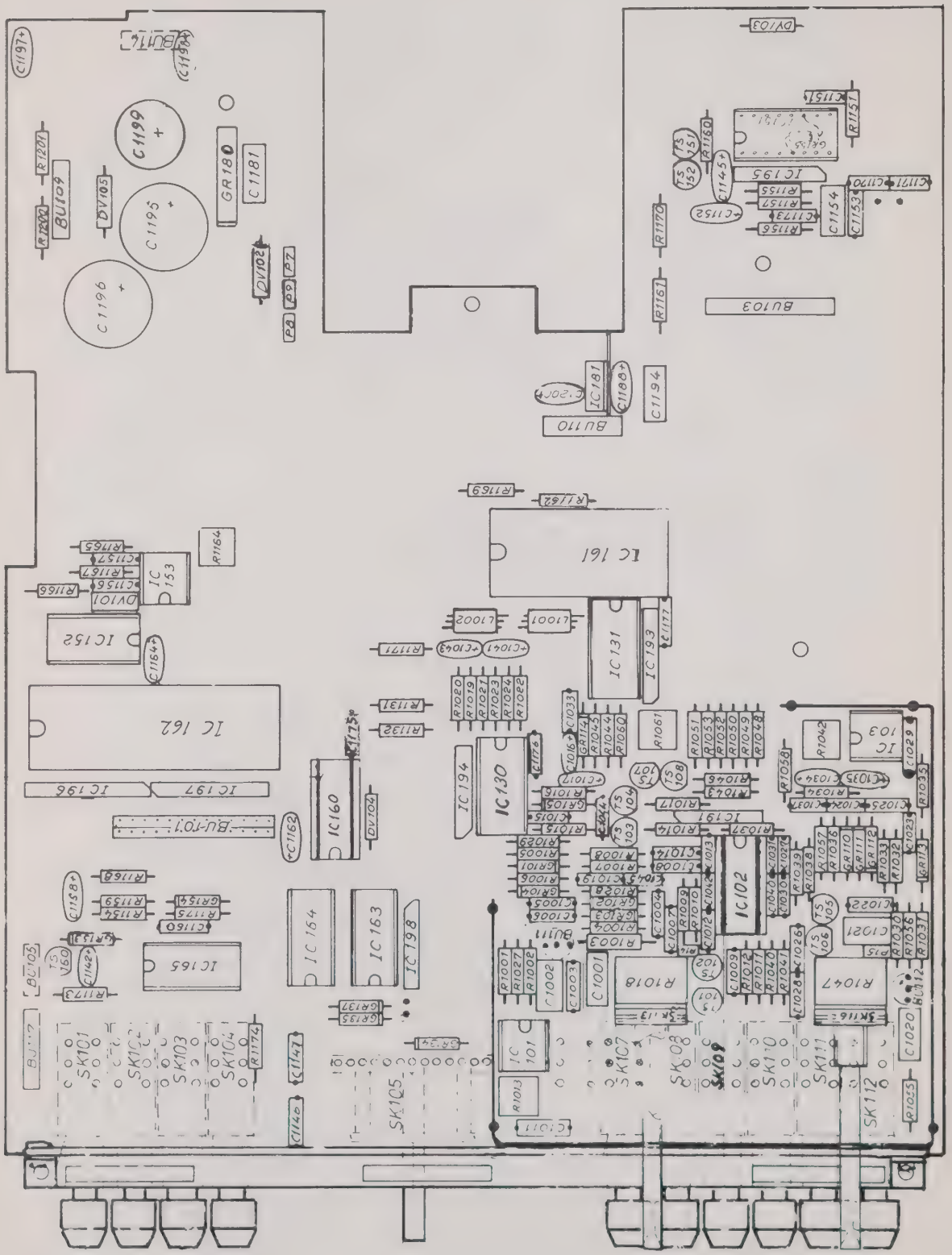


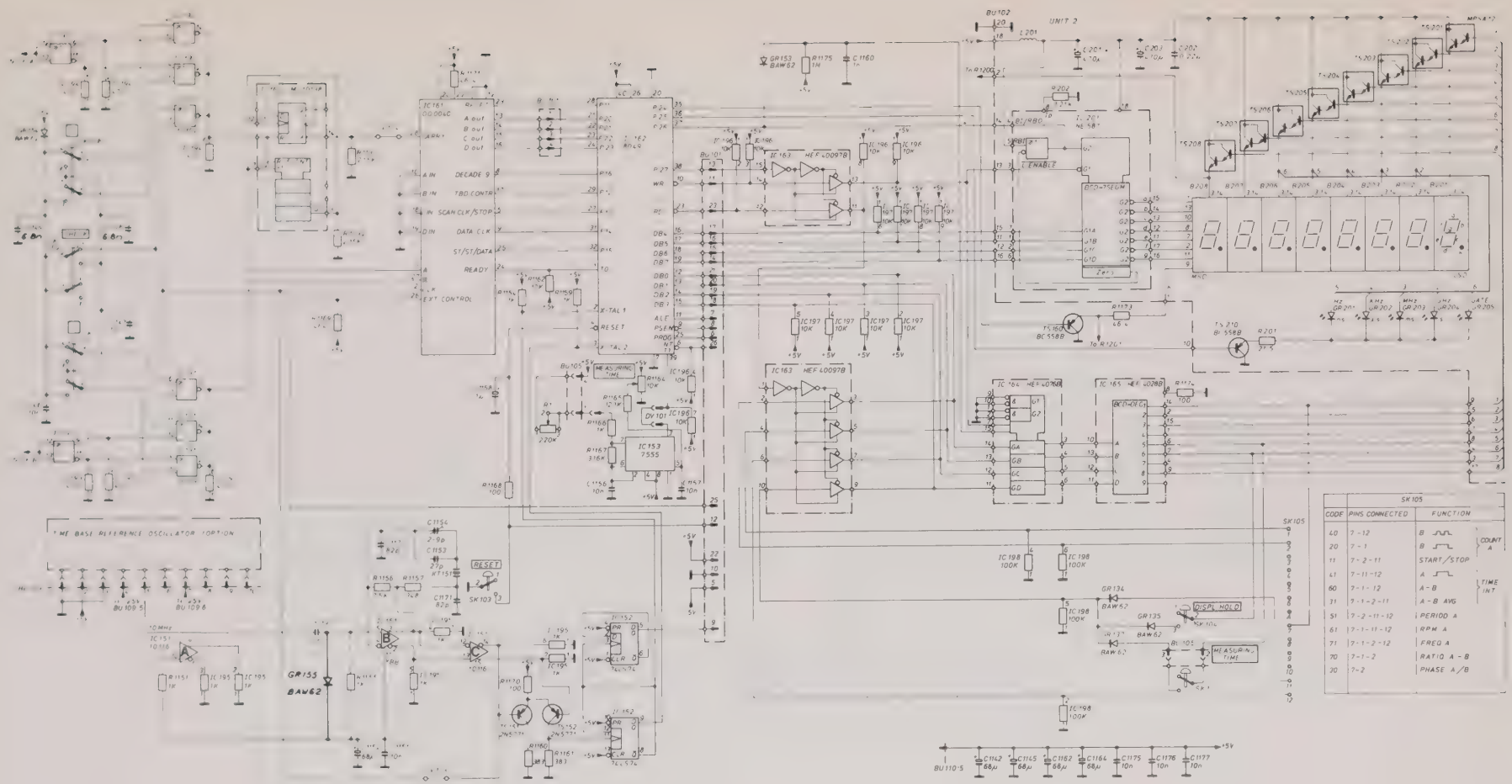
Block diagram



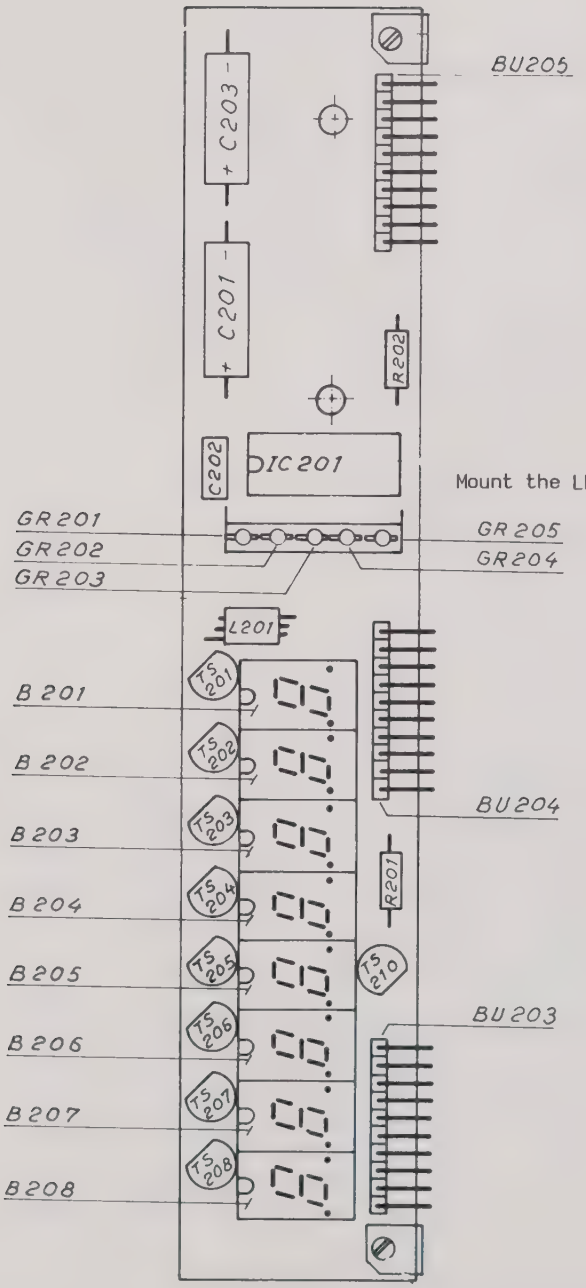
Functional block diagram



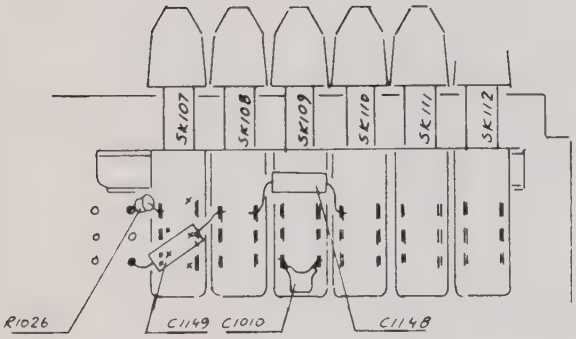
Input amplifier, logic and power supply



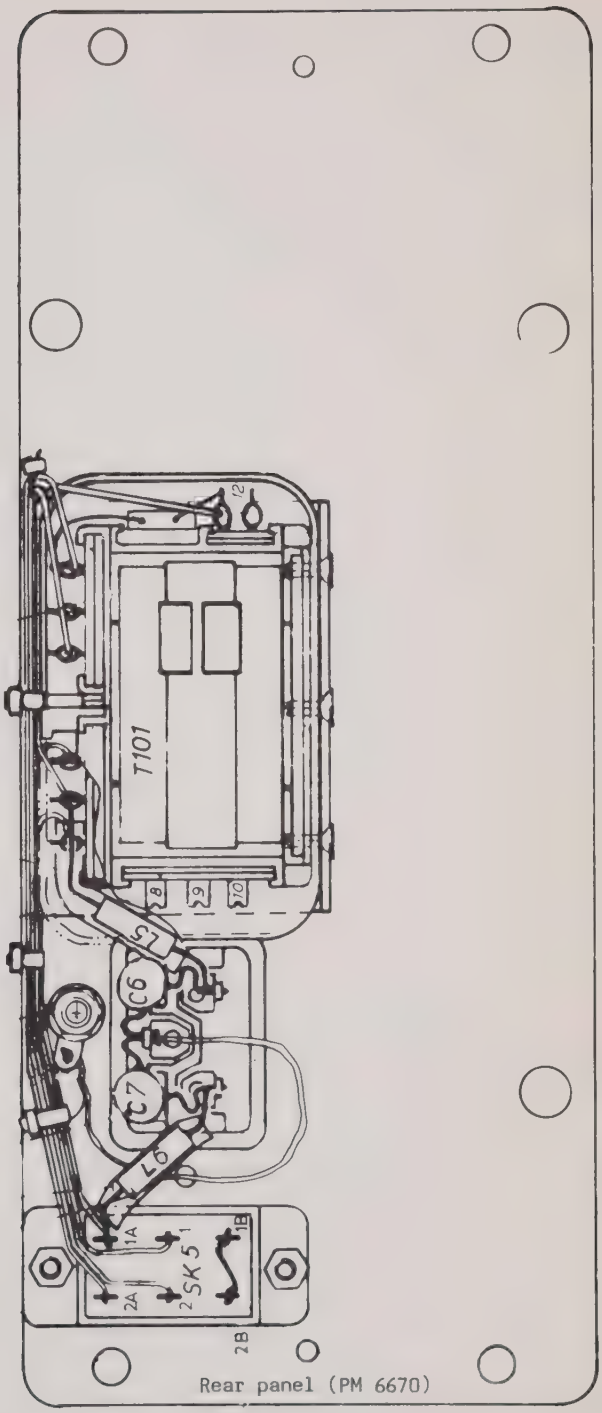
Item	Type	Pins	+5V	Ground
IC130	10102	16	1, 16	8
IC131	10102	16	1, 16	8
IC151	GXB 10116	16	1, 16	8
IC160	MC 10138	16	1, 16	8
IC163	HEF 40097B	16	16	8
IC164	HEF 4076B	16	16	8
IC165	HEF 4028B	16	16	8, via R1174
IC201	NE 587	18	18	9, 10



Mount the LED:s with the cathode towards R202

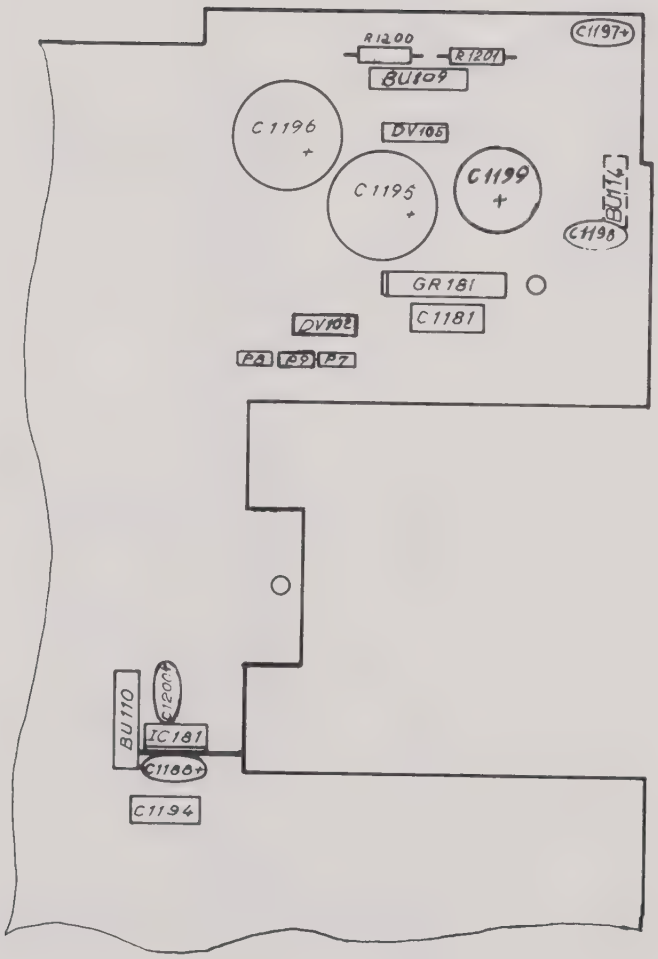


PM 6670

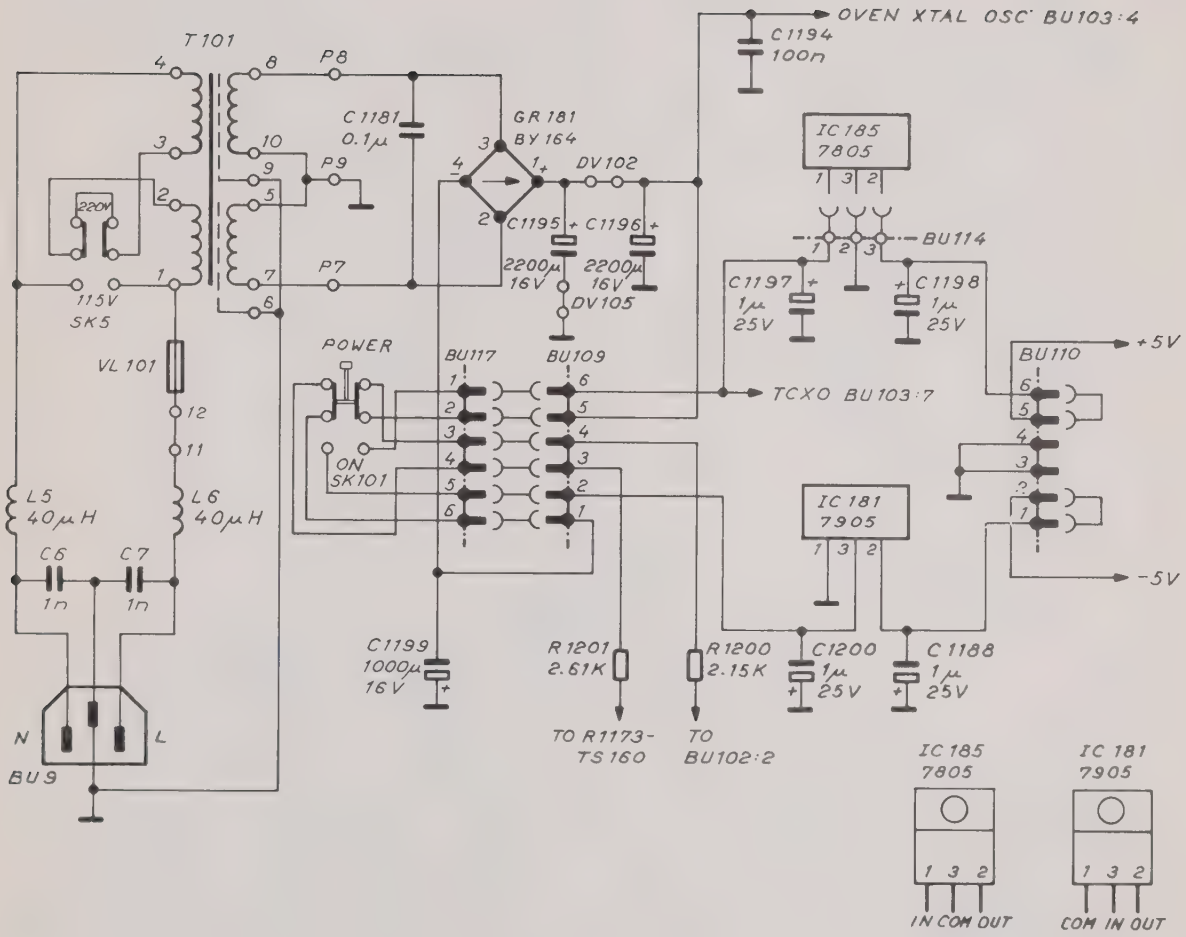


Rear panel (PM 6670)

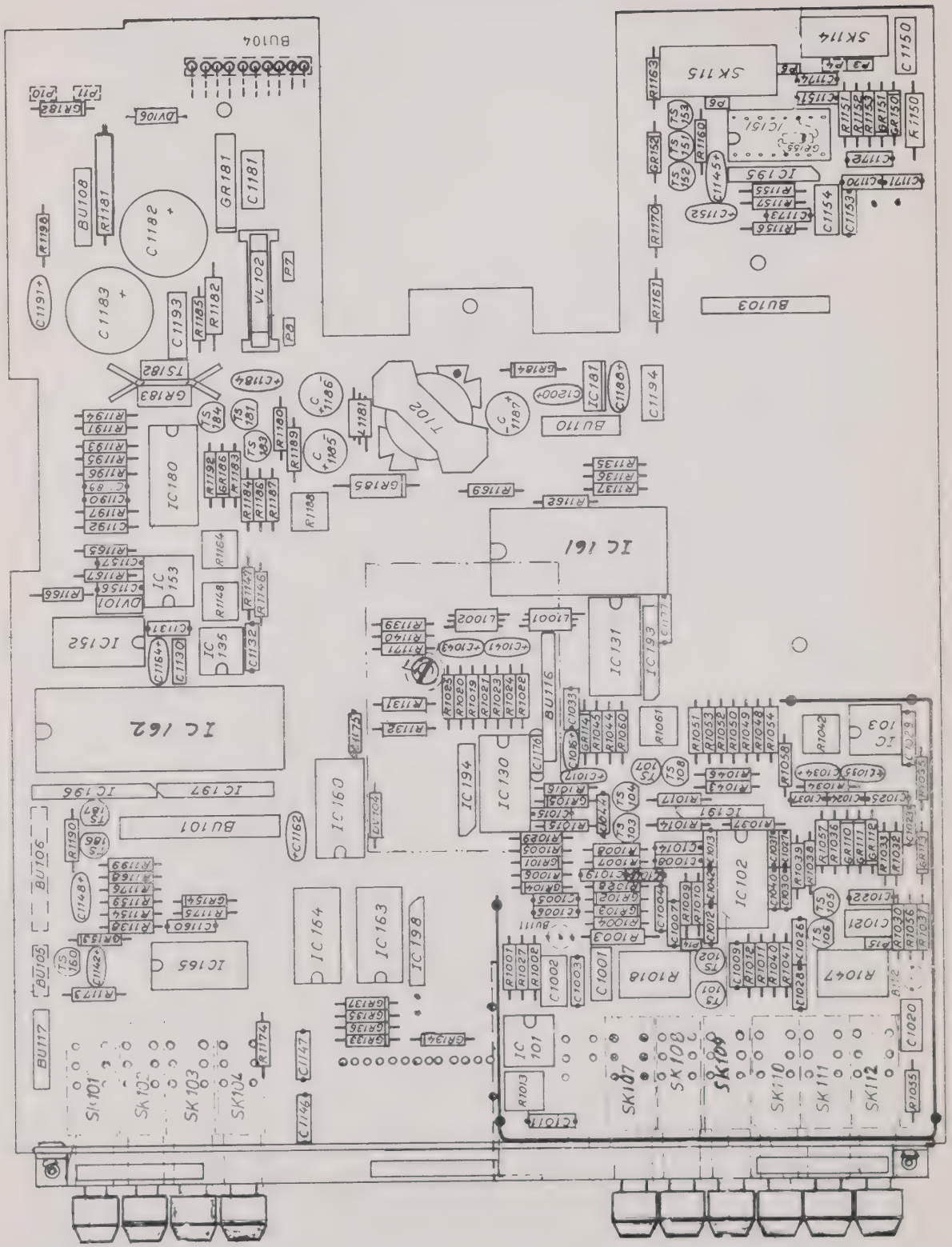
Components not fitted on PC-board



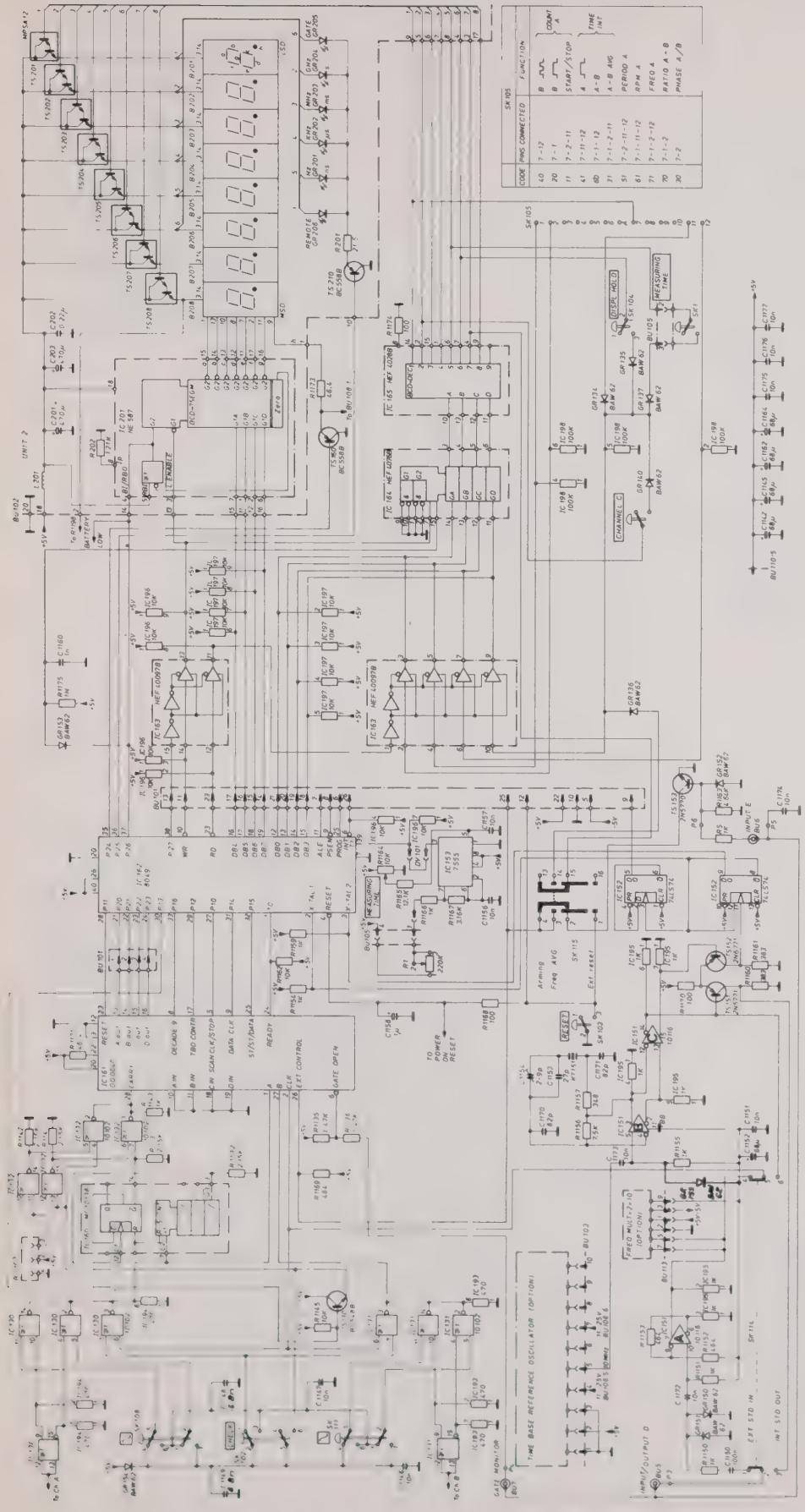
Power Supply



Power supply

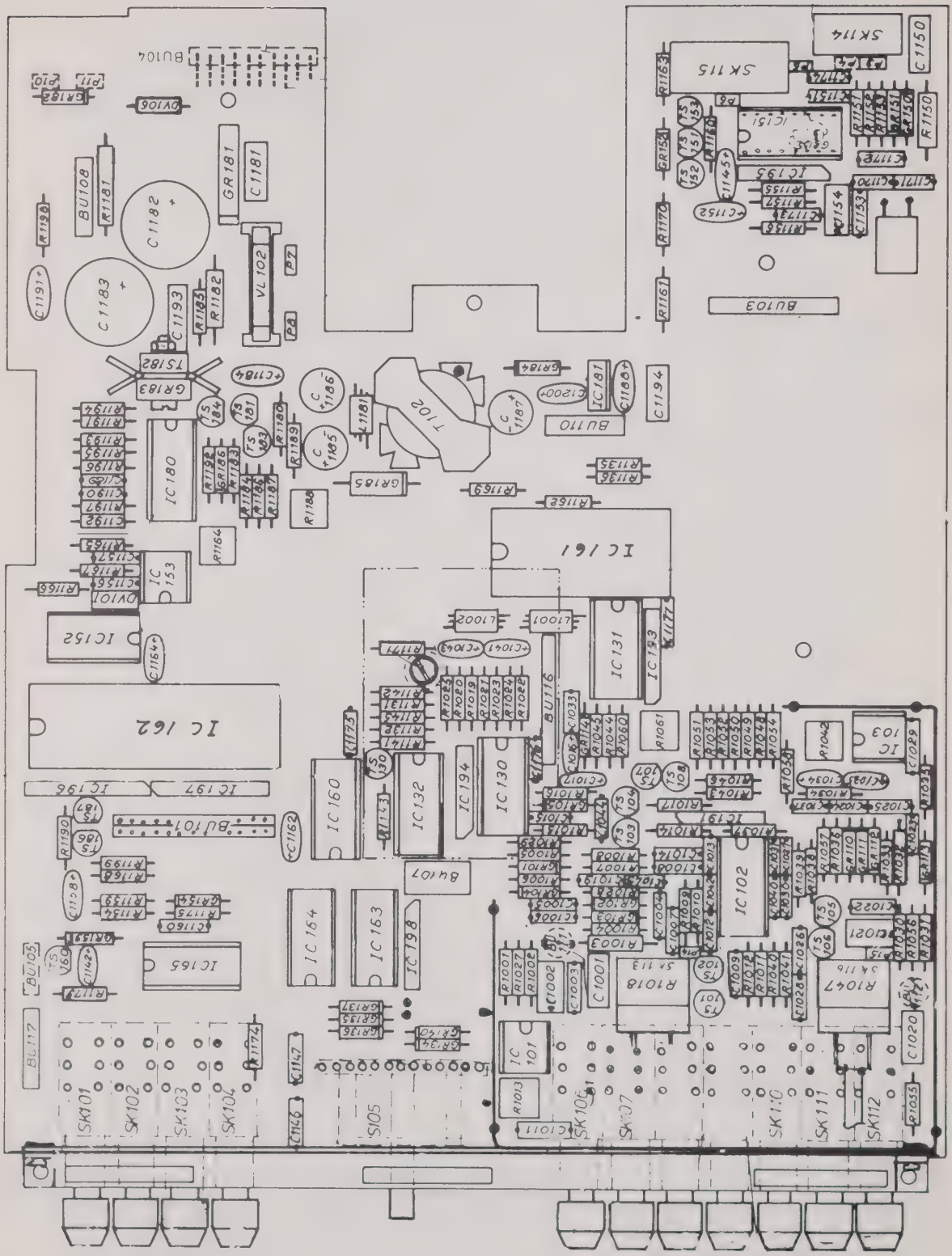


Input amplifier, logic and power supply

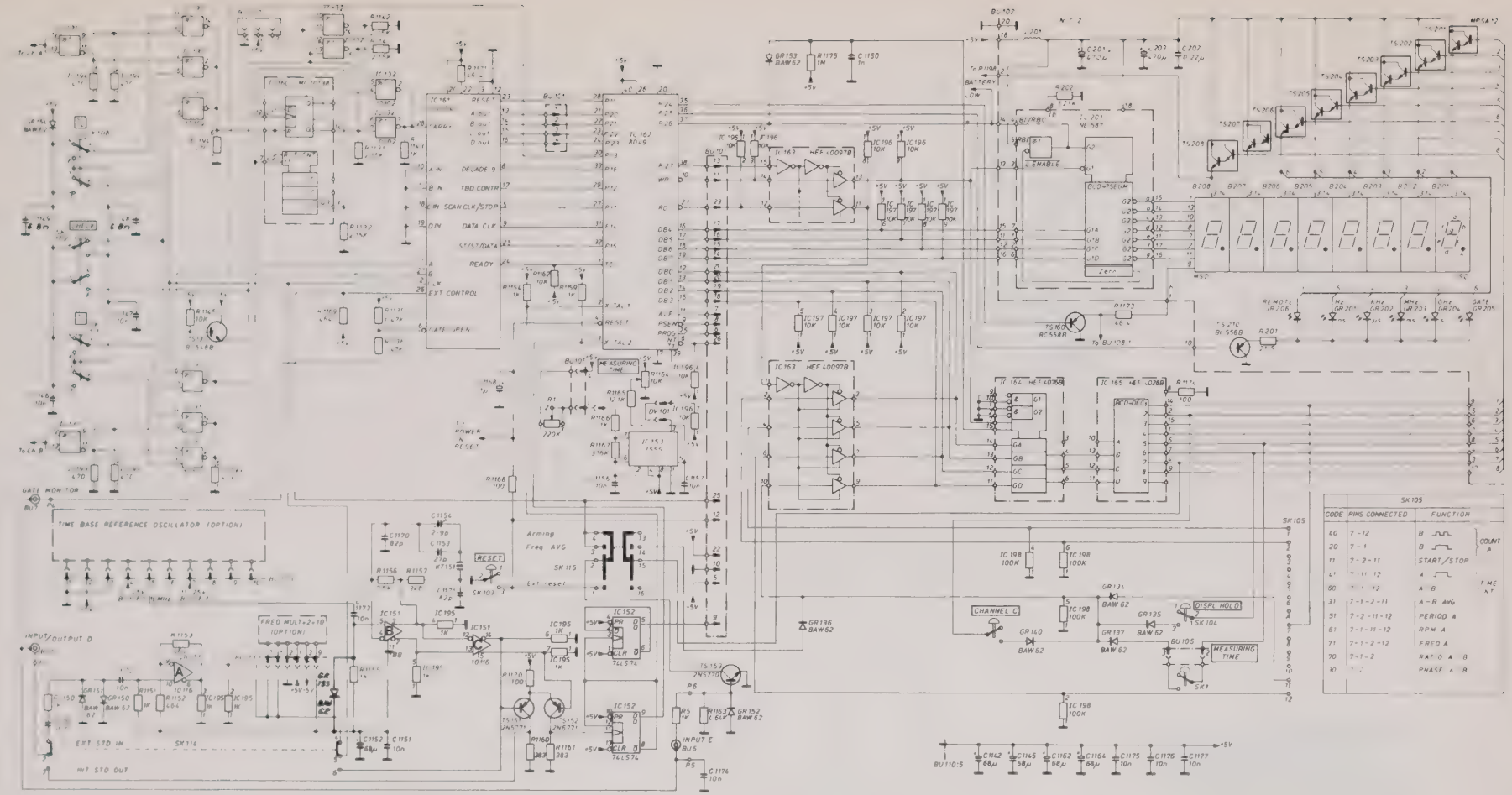


Item	Type	Pins	+5V	Ground
IC130	10102	16	1, 16	8
IC131	10102	16	1, 16	8
IC151	GXB 10116	16	1, 16	8
IC160	MC 10138	16	1, 16	8
IC163	HEF 40097B	16	16	8
IC164	HEF 4076B	16	16	8
IC165	HEF 4028B	16	16	8, via R1174
IC201	NE 587	18	18	9, 10

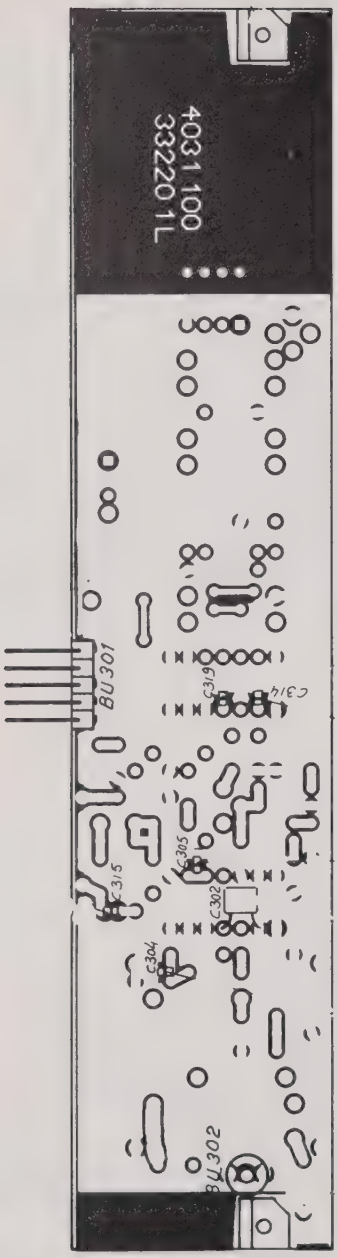
Logic and display (PM 6671)

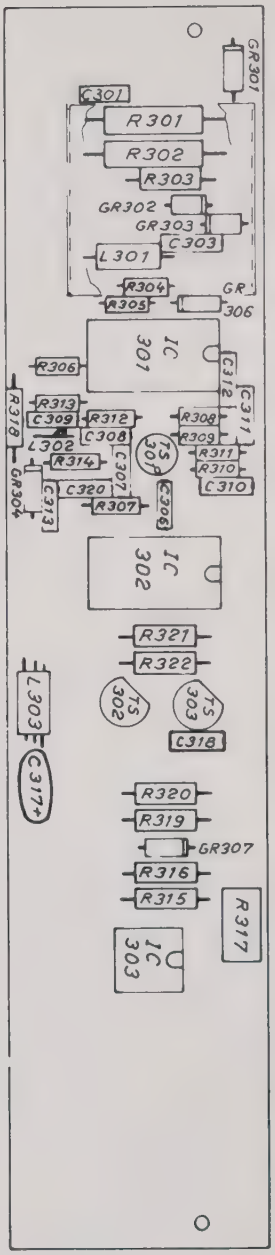


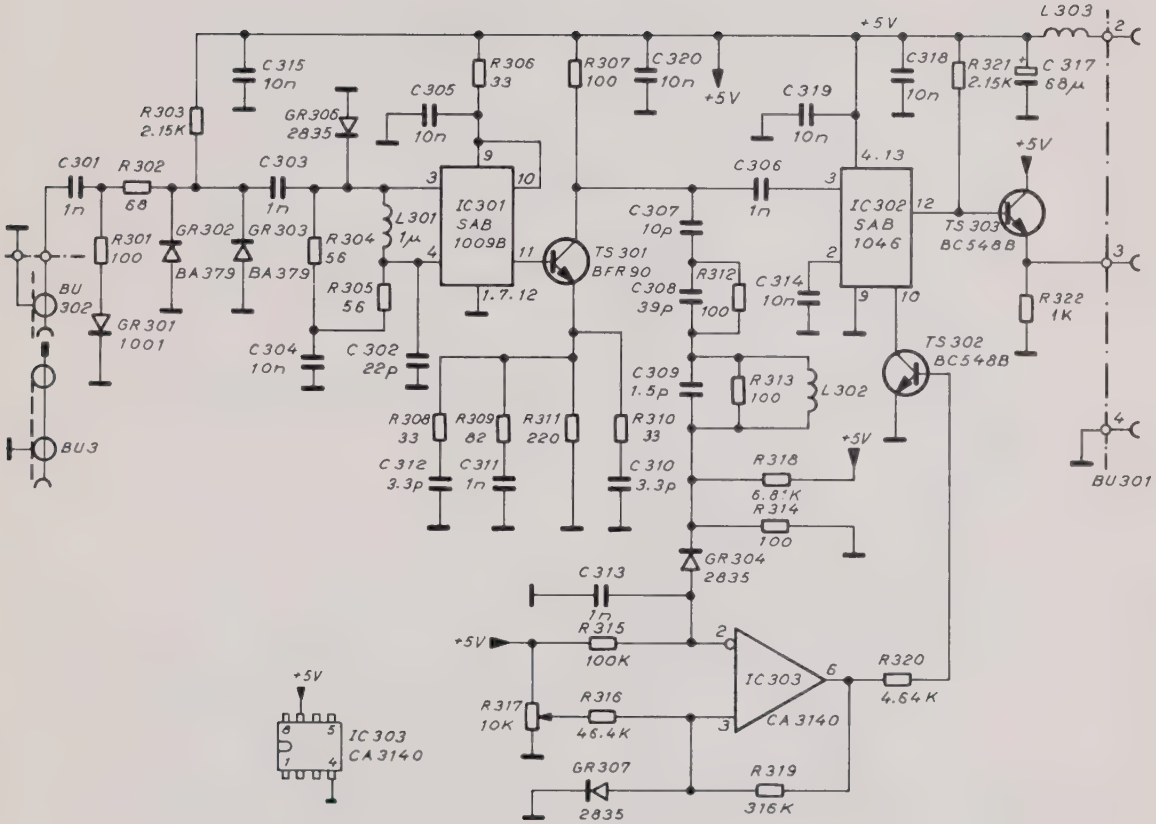
Input amplifier, logic and power supply (PM 6672)



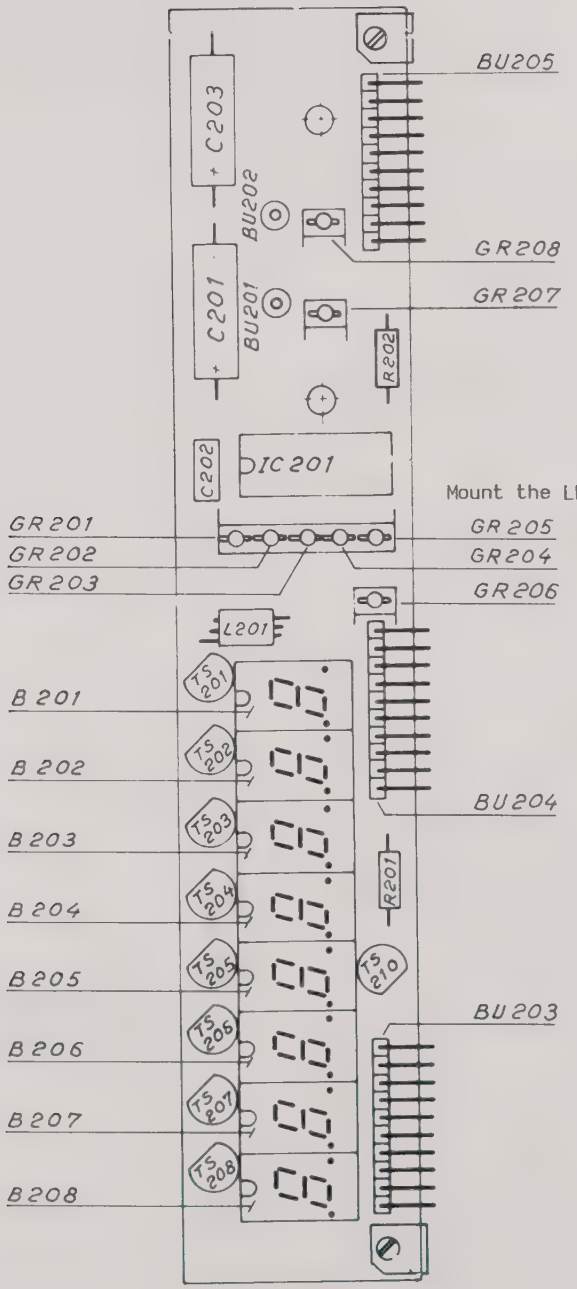
Item	Type	Pins	+5V	Ground
IC130	10102	16	1, 16	8
IC131	10102	16	1, 16	8
IC151	GXB 10116	16	1, 16	8
IC160	MC 10138	16	1, 16	8
IC163	HEF 40097B	16	16	8
IC164	HEF 4076B	16	16	8
IC165	HEF 4028B	16	16	8, via R1174
IC201	NE 587	18	18	9, 10

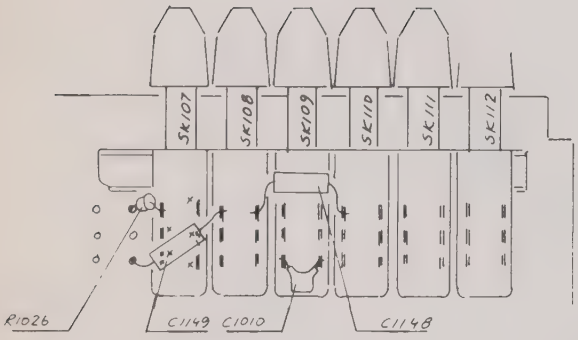

4031 100
33220 1L
BU301
C314
C319
C305
C315
C302
C304
BU302


GR301
C301
R301
R302
R303
GR302
GR303
C303
L301
R304
R305
GR 306
IC 301
R306
C312
C311
R313
C309
R312
C308
R308
R309
L302
R314
C307
TS 301
R311
R310
C310
GR304
C313
C320
R307
C306
IC 302
R321
R322
L303
TS 302
TS 303
C318
C317
R320
R319
GR307
R316
R315
R317
IC 303

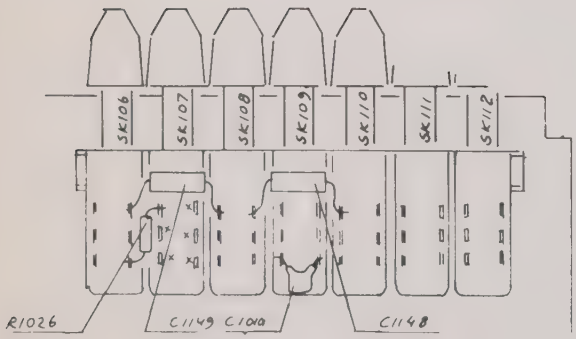


Item	Type	Pins	+5V	Ground
IC303	CA 3140	8	7	4

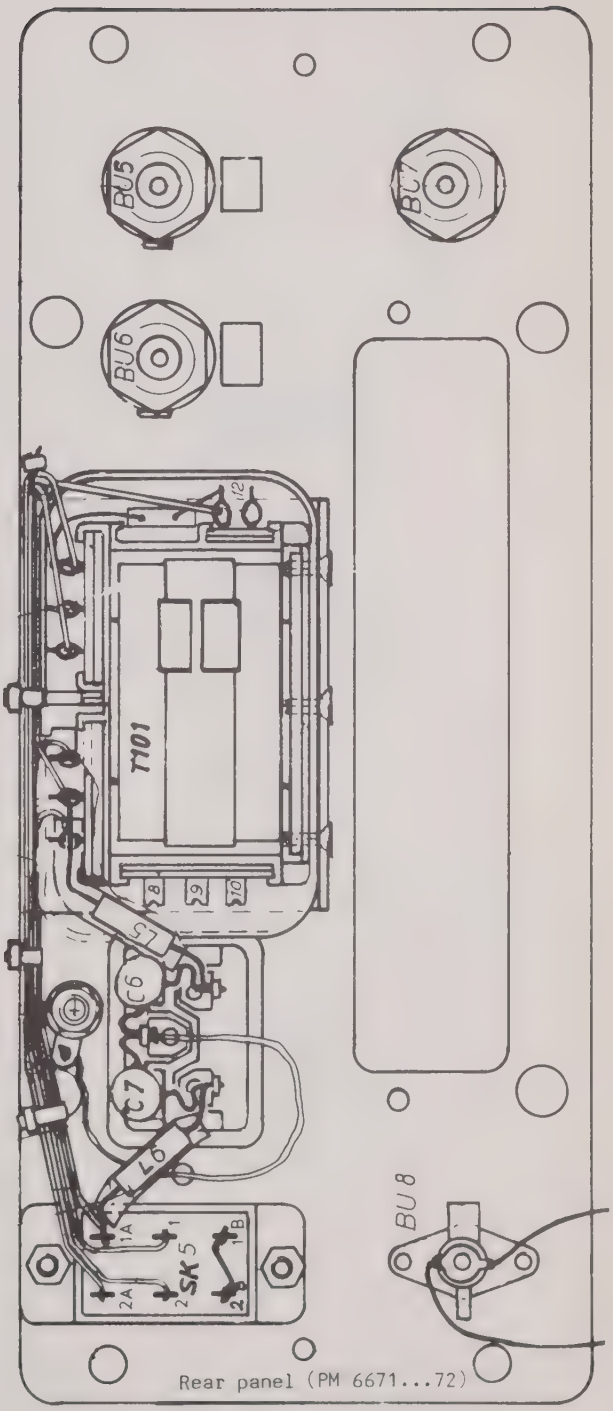

BU205
+ C203
BU202
GR208
+ C201
BU201
GR207
R202
C202
IC 201
Mount the LED:s with the cathode towards R202
GR201
GR202
GR203
GR205
GR204
GR206
L201
TS 201
B 201
TS 202
B 202
TS 203
B 203
TS 204
B 204
TS 205
B 205
TS 206
B 206
TS 207
B 207
TS 208
B 208
BU204
R207
TS 210
BU203



PM 6671

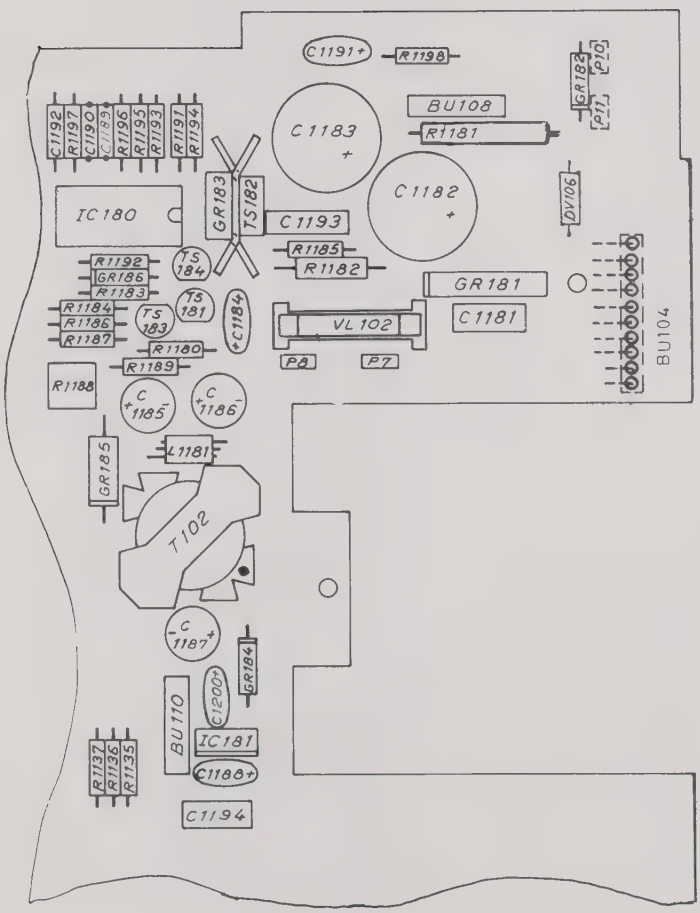


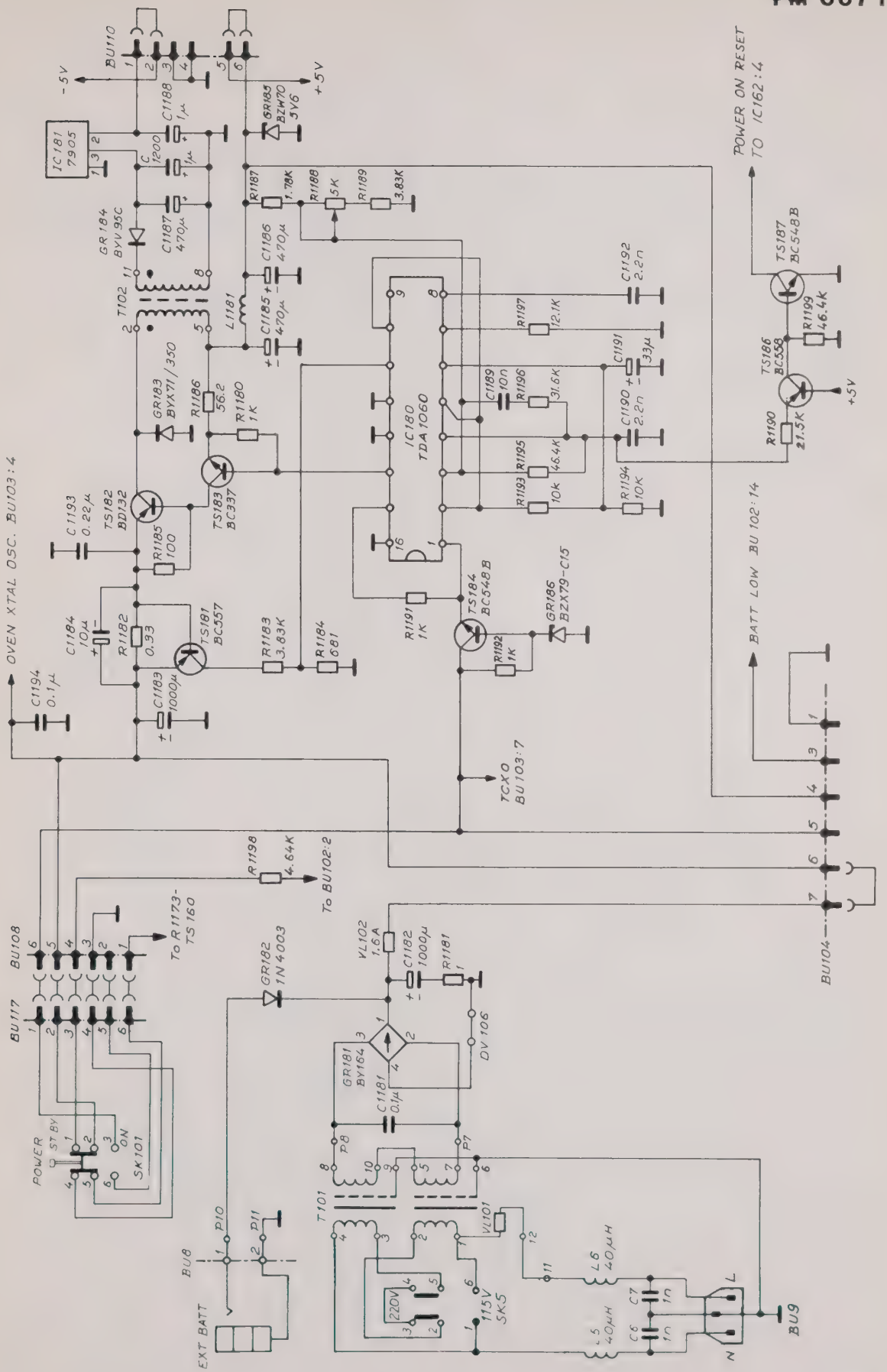
PM 6672



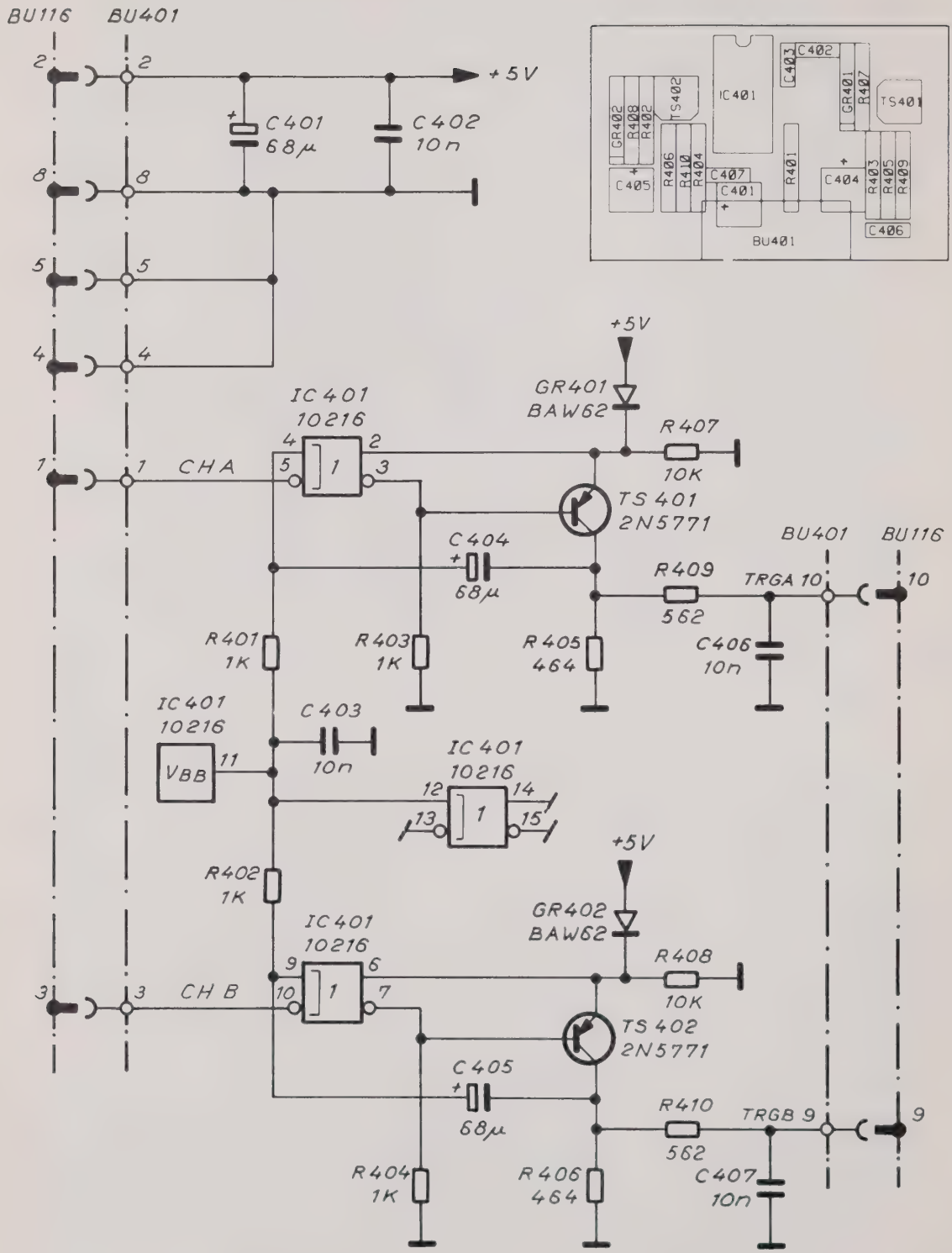
Rear panel (PM 6671...72)

Components not fitted on PC-board


C1191+
R1198
BU108
R1181
C1183
+
C1182
+
GR183
P11
P10
DV106
C1192
R1197
C1190
C1189
R1196
R1195
R1193
R1191
R1194
GR183
TS182
IC180
C1193
R1185
R1182
R1192
TS
184
GR186
R1183
GR181
C1181
R1184
TS
181
R1186
TS
183
R1187
+C1184
VL102
P8
P7
R1180
R1189
BU104
R1188
C
+
1185
C
+
1186
L1181
GR185
T102
C
1187
+
GR184
C1200+
BU110
IC181
R1137
R1136
R1135
C1188+
C1194

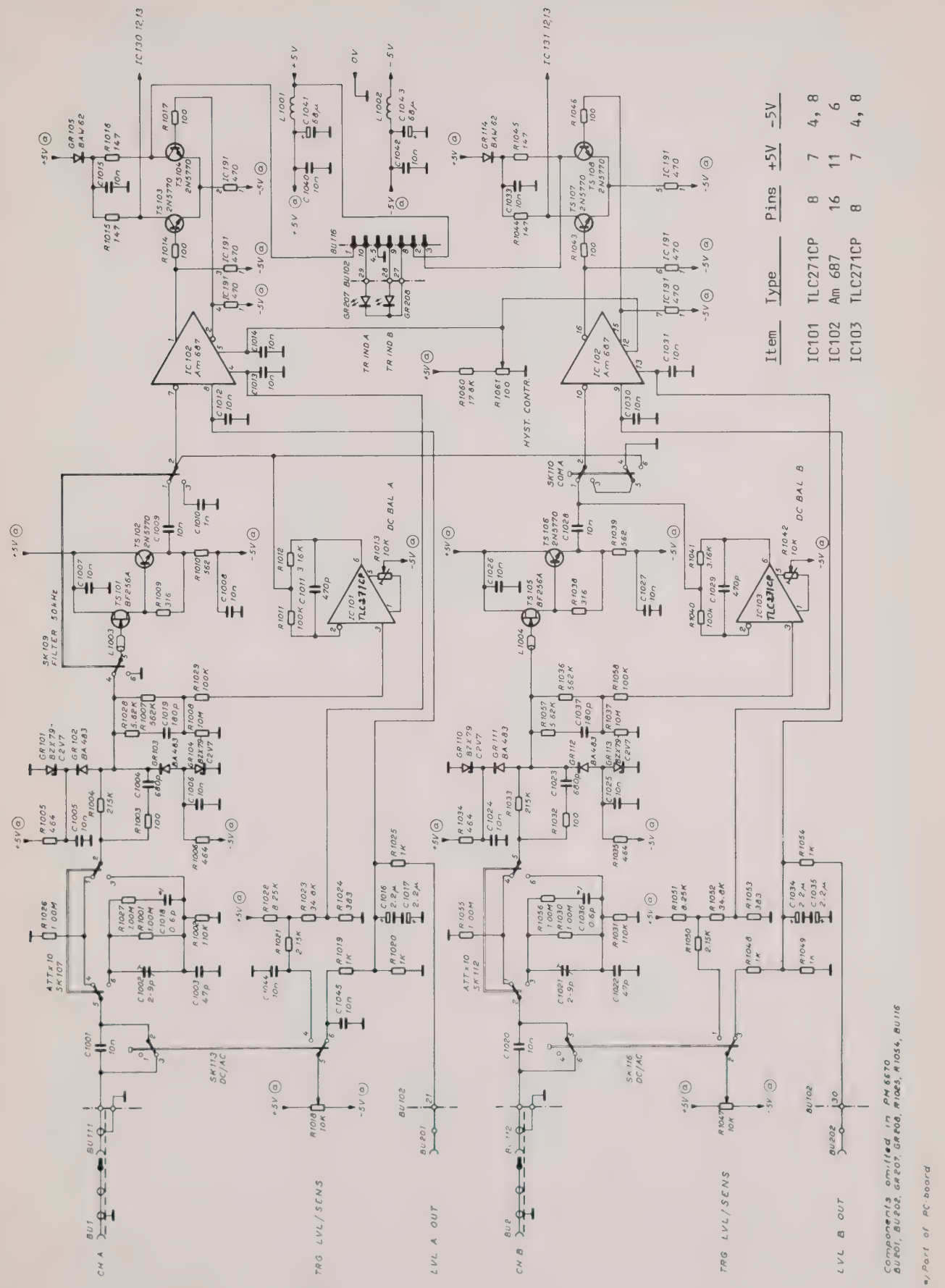


Power supply



Item	Type	Pins	+5V	Ground
IC401	10216	16	1, 16	8

Trigger indicator



Item	Type	Pins	+5V	-5V
IC101	TLC271CP	8	7	4, 8
IC102	Am 687	16	11	6
IC103	TLC271CP	8	7	4, 8

Components omitted in PM 6670
BU101, BU102, BU201, GR201, GR208, R1023, R1054, BU116

*) Part of PC board

8. SPARE PARTS LIST

Contents

Basic unit 8-2
Display unit 8-8
Prescaler unit 8-9
Trigger indicator unit 8-10
Panel mounted components 8-10
Mechanical parts 8-11

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
BU101	5322 265 51067	Connector	26 pole	
BU103	5322 265 64028	Socket, male	10 pole	
BU104	5322 265 40178	Connector	10 pole	
BU105	5322 265 44057	Connector	4 pole	
BU106	5322 265 64028	Socket, male	10 pole	
BU107	5322 265 30336	Connector	5 pole	
BU108...110	5322 265 44057	Connector	6 pole	
BU110/DV101	5322 253 64007	Jumper connector		
BU111, 112	5322 267 30501	Socket, female		
BU114	5322 265 64028	Socket, male	3 pole	
BU116	5322 265 40179	Connector	10 pole	
BU117	5322 265 44057	Connector	6 pole	
C1001	4822 121 41677	Cap. foil	10 nF ±10%	220 V
C1002	5322 125 50049	Cap. trimmer	10 pF	
C1003	4822 122 31072	Cap. ceramic	47 pF ±2%	100 V
C1004	5322 122 32419	Cap. ceramic	680 pF ±10%	500 V
C1005...1009	4822 122 31414	Cap. ceramic	10 nF	100 V
C1010	4822 122 30027	Cap. ceramic	1 nF ±10%	100 V
C1011	4822 122 30034	Cap. ceramic	470 pF ±2%	100 V
C1012...1015	4822 122 31414	Cap. ceramic	10 nF	100 V
C1016, 1017	4822 124 14066	Cap. solid alu.	10 µF	16 V
C1019	4822 122 30113	Cap. ceramic	180 pF ±10%	100 V
C1020	4822 121 41677	Cap. foil	10 nF ±10%	220 V
C1021	5322 125 50049	Cap. trimmer	10 pF	
C1022	4822 122 31072	Cap. ceramic	47 pF ±2%	100 V
C1023	5322 122 32419	Cap. ceramic	680 pF ±10%	500 V
C1024...1028	4822 122 31414	Cap. ceramic	10 nF	100 V
C1029	4822 122 30034	Cap. ceramic	470 pF ±2%	100 V
C1030, 1031	4822 122 31414	Cap. ceramic	10 nF	100 V
C1033	4822 122 31414	Cap. ceramic	10 nF	100 V
C1034, 1035	5322 124 14066	Cap. solid alu.	10 µF	16 V
C1037	4822 122 30113	Cap. ceramic	180 pF ±10%	100 V
C1040	4822 122 31414	Cap. ceramic	10 nF	100 V
C1041	5322 124 10455	Cap. tantal	68 µF	6.3 V
C1042	4822 122 31414	Cap. ceramic	10 nF	100 V
C1043	5322 124 10455	Cap. tantal	68 µF	6.3 V
C1044, 1045	4822 122 31414	Cap. ceramic	10 nF	100 V
C1130	5322 121 42347	Cap. foil	220 nF	63 V
C1131	4822 122 31414	Cap. ceramic	10 nF	100 V
C1132	4822 122 31125	Cap. ceramic	4.7 nF	63 V
C1142	5322 124 10455	Cap. tantal	68 µF	6.3 V

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
C1145	5322 124 10455	Cap. tantal	68 µF	6.3 V
C1146, 1147	4822 122 31414	Cap. ceramic	10 nF	100 V
C1148, 1149	4822 121 50538	Cap. foil	6.8 nF ±1%	63 V
C1150	4822 121 41672	Cap. foil	100 nF ±10%	63 V
C1151	4822 122 31414	Cap. ceramic	10 nF	100 V
C1152	5322 124 10455	Cap. tantal	68 µF	6.3 V
C1153	4822 122 30045	Cap. ceramic	27 pF ±2%	100 V
C1154	5322 125 50049	Cap. trimmer	10 pF	
C1156	5322 121 42348	Cap. foil	10 nF	63 V
C1157	4822 122 31414	Cap. ceramic	10 nF	100 V
C1158	4822 124 21457	Cap. solid alu.	1 µF ±10%	25 V
C1160	4822 122 30027	Cap. ceramic	1 nF ±10%	100 V
C1162	5322 124 10455	Cap. tantal	68 µF	6.3 V
C1164	5322 124 10455	Cap. tantal	68 µF	6.3 V
C1170, 1171	4822 122 31237	Cap. ceramic	82 pF ±2%	100 V
C1172...1177	4822 122 31414	Cap. ceramic	10 nF	100 V
C1181	4822 121 41672	Cap. foil	100 nF	63 V
C1182, 1183	5322 124 21165	Cap. electrolyt.	100 µF	40 V
C1184	5322 124 14066	Cap. solid alu.	10 µF	16 V
C1185...1187	5322 124 21349	Cap. electrolyt.	470 µF	10 V
C1188	5322 124 14066	Cap. solid alu.	10 µF	16 V
C1189	4822 122 31414	Cap. ceramic	10 nF	100 V
C1190	4822 122 30114	Cap. ceramic	2.2 nF ±10%	100 V
C1191	4822 124 20945	Cap. solid alu.	33 µF	10 V
C1192	5322 121 54071	Cap. foil	2.2 nF ±1%	250 V
C1193	4822 121 40232	Cap. foil	220 nF ±10%	100 V
C1194	4822 121 41672	Cap. foil	100 nF ±10%	63 V
C1195, 1196	4822 124 21214	Cap. electrolyt.	2200 µF	16 V
C1197, 1198	5322 124 14066	Cap. solid alu.	10 µF	16 V
C1199	5322 124 70405	Cap. electrolyt.	1000 µF	10 V
C1200	5322 124 14066	Cap. solid alu.	10 µF	16 V
DV101	5322 265 44074	Connector	2-pin	
DV101/BU110	5322 253 64007	Jumper connector		
DV102...106	5322 116 52929	Res. metal film	0 ohm (wire link)	
GR101	5322 130 34563	Diode, reference	BZX79/C2V7	
GR102, 103	4822 130 32656	Diode	BA483	
GR104	5322 130 34563	Diode, reference	BZX79/C2V7	
GR105	5322 130 30613	Diode	BAW62	
GR110	5322 130 34563	Diode, reference	BZX79/C2V7	
GR111, 112	4822 130 32656	Diode	BA483	
GR113	5322 130 34563	Diode, reference	BZX79/C2V7	

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
GR114	4822 130 30613	Diode	BAW62	
GR133...137	4822 130 30613	Diode	BAW62	
GR140	4822 130 30613	Diode	BAW62	
GR150...155	4822 130 30613	Diode	BAW62	
GR180, 181	5322 130 32031	Bridge rect.	SKB2/08L5A	
GR182	4822 130 31174	Diode	1N4003	
GR183	4822 130 32119	Diode	BY229-600	
GR184	4822 130 41487	Diode	BYV95C	
GR185	5322 130 32667	Diode	BZW70-5V6	
GR186	4822 130 34281	Diode, reference	BZX79/B15	
IC101	5322 209 83069	IC	TLC 271 CP *	See NOTE below.
IC102	5322 209 82866	IC	AM687DL	
IC103	5322 209 83069	IC	TLC 271 CP *	See NOTE below.
IC130...132	5322 209 84643	IC	10102L	
IC135	5322 209 82831	IC	ICM7555IPA	
IC151	5322 209 86441	IC	10116N	
IC152	4822 209 80782	IC	74LS74AN	
IC153	5322 209 82831	IC	ICM7555IPA	
IC160	5322 209 86203	IC	10138P	
IC161	5322 209 10988	IC	OQ0040	
IC162	5322 209 82857	IC, Microcomputer		
IC163	4822 209 10317	IC	40097BD	
IC164	4822 209 10051	IC	4076BP	
IC165	4822 209 10301	IC	4028BD	
IC180	5322 209 85662	IC	TDA1060	
IC181	5322 130 44843	IC	7905	
IC185	5322 209 84454	IC	7805	
IC191...194	5322 111 90742	Combination, RC	Res. network	470 ohm
IC195	5322 111 94015	Compositionres.,	Res. network	1 kohm
IC196, 197	5322 111 90079	Res. carbon,	Res. network	10 kohm
IC198	5322 111 90081	Res. carbon,	Res. network	100 kohm
KT151	5322 242 74372	Crystal		
L101, 102	5322 158 10052	COIL		
L1001, 1002	5322 158 10052	COIL		
L1003, 1004	4822 526 10025	Core, ferroxcube	yellow	
L1181	5322 158 10052	COIL		
R1/SK1	5322 462 30207	Potentiometer	220 kohm lin.	with switch
R1001	5322 116 55535	Res. metal film	1 Mohm 1%	0.4 W

* NOTE The circuit board must be modified when changing from CA3140 to TLC 271 CP, see chapter 6.

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
R1002	5322 116 54701	Res. metal film	110 kohm 1%	0.4 W
R1003	5322 116 51098	Res. metal film	100 ohm 5%	1.6 W
R1004	5322 116 54728	Res. metal film	215 kohm 1%	0.4 W
R1005	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R1006	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R1007	4822 116 51169	Res. metal film	620 kohm 1%	0.4 W
R1008	4822 110 72214	Res. HI-tension	10 Mohm 5%	0.25 W
R1009	5322 116 54511	Res. metal film	316 ohm 1%	0.4 W
R1010	4822 116 51231	Res. metal film	562 ohm 0.5%	0.4 W
R1011	4822 116 51268	Res. metal film	100 kohm 0.5%	0.4 W
R1012	5322 116 50579	Res. metal film	3.16 kohm 1%	1/8 W
R1013	5322 101 14194	Potm. trimmer cerm	10 kohm lin.	0.5 W
R1014	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W
R1015	5322 116 50766	Res. metal film	147 ohm 1%	1/8 W
R1016	5322 116 50766	Res. metal film	147 ohm 1%	1/8 W
R1017	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W
R1018/SK113	5322 101 20803	Potm. carb. track	10 kohm lin	with switch
R1019, 1020	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1021	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R1022	5322 116 54558	Res. metal film	8.25 kohm 1%	0.4 W
R1023	5322 116 54661	Res. metal film	34.8 kohm 1%	0.4 W
R1024	5322 116 55368	Res. metal film	383 ohm 0.5%	0.4 W
R1025	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1026, 1027	5322 116 55535	Res. metal film	1 Mohm 1%	0.4 W
R1027	5322 116 55535	Res. metal film	1 Mohm 1%	0.4 W
R1028	4822 101 51281	Res. metal film	5.62 kohm 0.5%	0.4 W
R1029	4822 116 51268	Res. metal film	100 kohm 0.5%	0.4 W
R1030	5322 116 55535	Res. metal film	1 Mohm 1%	0.4 W
R1031	5322 116 54701	Res. metal film	110 kohm 1%	0.4 W
R1032	4822 116 51098	Res. metal film	100 ohm 5%	1.6 W
R1033	5322 116 54728	Res. metal film	215 kohm 1%	0.4 W
R1034, 1035	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R1036	4822 116 51169	Res. metal film	620 kohm 1%	0.4 W
R1037	5322 116 72214	Res. HI-tension	10 Mohm 5%	0.25 W
R1038	5322 116 54511	Res. metal film	316 ohm 1%	0.4 W
R1039	4822 116 51231	Res. metal film	562 ohm 0.5%	0.4 W
R1040	4822 116 51268	Res. metal film	100 kohm 0.5%	0.4 W
R1041	5322 116 50579	Res. metal film	3.16 kohm 1%	1/8 W
R1042	5322 101 14194	Potm. trimmer cerm.	10 kohm lin	0.5 W
R1043	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
R1044, 1045	5322 116 50766	Res. metal film	147 ohm 1%	1/8 W
R1046	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W
R1047/SK116	5322 101 20803	Potm. carb. track	10 kohm lin	with switch
R1048, 1049	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1050	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R1051	5322 116 54558	Res. metal film	8.25 kohm 1%	0.4 W
R1052	5322 116 54661	Res. metal film	34.8 kohm 1%	0.4 W
R1053	5322 116 55368	Res. metal film	383 ohm 0.5%	0.4 W
R1054	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1055, 1056	5322 116 55535	Res. metal film	1 Mohm 1%	0.4 W
R1057	4822 116 51281	Res. metal film	5.62 kohm 0.5%	0.4 W
R1058	4822 116 51268	Res. metal film	100 kohm 0.5%	0.4 W
R1060	5322 116 54637	Res. metal film	17.8 kohm 1%	0.4 W
R1061	5322 101 10542	Potm. trimmer cerm.	100 ohm 10%	0.5 W
R1131, 1132	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R1135	5322 116 50635	Res. metal film	1.47 kohm 1%	0.4 W
R1136	5322 116 50635	Res. metal film	1.47 kohm 1%	0.4 W
R1137	5322 116 50579	Res. metal film	3.16 kohm 1%	1/8 W
R1138	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R1139, 1140	4822 116 51253	Res. metal film	10 kohm 0.5%	0.4 W
R1141, 1142	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R1143	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1145, 1146	4822 116 51235	Res. metal film	10 kohm 0.5%	0.4 W
R1147	5322 116 50572	Res. metal film	12.1 kohm 1%	0.4 W
R1148	5322 101 14194	Potm. trimmer cerm.	10 kohm	0.5 W
R1150	5322 116 54909	Res. metal film	1 kohm 5%	1.6 W
R1151	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1152, 1153	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R1154, 1155	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1156	5322 116 54608	Res. metal film	7.5 kohm 1%	0.4 W
R1157	5322 116 54515	Res. metal film	384 ohm 1%	0.4 W
R1159	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1160, 1161	5322 116 55368	Res. metal film	383 ohm 0.5%	0.4 W
R1162	4822 116 51253	Res. metal film	10 kohm 0.5%	0.4 W
R1163	5322 116 50484	Res. metal film	4.64 kohm 1%	0.4 W
R1164	5322 101 14194	Potm. trimmer cerm.	10 kohm	0.5 W
R1165	5322 116 50572	Res. metal film	12.1 kohm 1%	0.4 W
R1166	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1167	5322 116 50579	Res. metal film	3.16 kohm 1%	1/8 W
R1168	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
R1169	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R1170	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W
R1171	5322 116 50492	Res. metal film	46.4 ohm 1%	0.4 W
R1173	5322 116 50492	Res. metal film	46.4 ohm 1%	0.4 W
R1174	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W
R1175	5322 116 55535	Res. metal film	1 Mohm 1%	0.4 W
R1176	4822 116 51233	Res. metal film	681 ohm 0.5%	0.4 W
R1177	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1180	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1181	4822 116 60084	Res. wirewound	1 ohm 5%	1 W
R1182	5322 116 52928	Res. metal film	0.33 ohm 10%	0.7 W
R1183	5322 116 54589	Res. metal film	3.83 kohm 1%	0.4 W
R1184	5322 116 51233	Res. metal film	681 ohm 0.5%	0.4 W
R1185	5322 116 55549	Res. metal film	100 ohm 1%	0.4 W
R1186	5322 116 54446	Res. metal film	56.2 ohm 1%	0.4 W
R1187	5322 116 50515	Res. metal film	1.78 kohm 1%	0.4 W
R1188	5322 101 14272	Potm. trimmer cerm.	5 kohm	0.5 W
R1189	5322 116 54589	Res. metal film	3.83 kohm 1%	0.4 W
R1190	5322 116 50451	Res. metal film	21.5 kohm 1%	0.4 W
R1191, 1192	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R1193, 1194	4822 116 51235	Res. metal film	10 kohm 0.5%	0.4 W
R1195	5322 116 50557	Res. metal film	46.4 kohm 1%	0.4 W
R1196	5322 116 54657	Res. metal film	31.6 kohm 1%	0.4 W
R1197	5322 116 50572	Res. metal film	12.1 kohm 1%	0.4 W
R1198	5322 116 50484	Res. metal film	4.64 kohm 1%	0.4 W
R1199	5322 116 50557	Res. metal film	46.4 kohm 1%	0.4 W
R1200	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R1201	5322 116 50671	Res. metal film	2.61 kohm 1%	0.4 W
SK101	5322 116 11282	Switch,	pushbutton	
SK102...104	5322 276 11282	Switch,	pushbutton	
SK105	5322 276 40337	Switch,	rotary	
SK106	5322 276 70085	Switch,	pushbutton	
SK107...112	5322 276 60229	Switch,	pushbutton	
SK113	See R1018			
SK114	5322 276 10911	Switch,	slide	
SK115	5322 276 11445	Switch,	slide	
SK116	See R1047			
TS101	5322 130 44418	Transistor, FET	BF256A	
TS102...104	5322 130 44435	Transistor,	2N5770	
TS105	5322 130 44418	Transistor, FET	BF256A	

BASIC UNIT (input amplifier, logic and power supply)

Pos. No.	Order No.	Description		
TS106...108	5322 130 44435	Transistor,	2N5770	
TS130	4822 130 40937	Transistor,	BC548B	
TS151, 152	5322 130 44845	Transistor,	2N5771	
TS153	5322 130 44435	Transistor,	2N5770	
TS160	4822 130 44197	Transistor,	BC558B	
TS181	4822 130 44256	Transistor,	BC557	
TS182	5322 130 40753	Transistor,	BD132	
TS183	4822 130 40855	Transistor,	BC337	
TS184	4822 130 40937	Transistor,	BC548B	
TS186	5322 130 44197	Transistor,	BC558B	
TS187	4822 130 40937	Transistor,	BC548B	
T101	5322 146 10001	Transformer, Mains		
T102	5322 146 20982	Transformer, SMPS		
VL101	4822 252 20007	Thermal fuse	125 °C / 900 mA	
VL102	5322 256 34104	Holder, fuse		
VL102	4822 253 20022	Fuse 1.6 A fast-blow	5x20 mm	

DISPLAY UNIT

Pos.No.	Order No.	Description		
BU2	5322 267 10004	Plug, coax. female		
BU201	5322 290 30233	Testpoint on front panel	PM 6671, 72	
BU202	5322 290 30233	Testpoint on front panel	PM 6671, 72	
B201...208	5322 130 90228	Display	7651	
C201	4822 124 20673	Cap. electrolyt.	470 µF	6.3 V
C202	5322 121 42347	Cap. foil	220 nF	63 V
C203	4822 124 20673	Cap. electrolyt.	470 µF	6.3 V
GR201...208	5322 130 31502	LED,	yellow	3 mm
IC201	5322 209 81435	IC	NE587N	
L201	5322 158 10052	COIL		
R2/SK2	5322 101 20804	Potm. carb. track	1 Mohm log	with switch
R201	5322 116 50677	Res. metal film	21.5 ohm 1%	0.4 W
R202	5322 116 54557	Res. metal film	1.21 kohm 1%	0.4 W
TS201...208	5322 130 41682	Transistor,	MPSA12	
TS210	4822 130 44197	Transistor,	BC558B	

PRESCALER UNIT

Pos. No.	Order No.	Description		
BU3	5322 267 10004	Plug, coax. female		
BU301	5322 265 40379	Connector	5 pole	
BU302	5322 267 30501	Socket,	female	
C301	5322 122 32127	Cap. ceramic	1 nF ±10%	500 V
C302	4822 122 31063	Cap. ceramic	22 pF ±2%	100 V
C303	4822 122 30027	Cap. ceramic	1 nF ±10%	100 V
C304, 305	5322 122 34098	Cap. chip	10 nF	50 V
C306	4822 122 30027	Cap. ceramic	1 nF ±10%	100 V
C307	4822 122 32185	Cap. ceramic	10 pF ±2%	100 V
C308	4822 122 31069	Cap. ceramic	39 pF ±2%	100 V
C309	5322 122 32101	Cap. ceramic	1.5 ±0.25 pF	100 V
C310	4822 122 31821	Cap. chip	3.3 ±0.25 pF	100 V
C311	4822 122 30027	Cap. ceramic	1 nF ±10%	100 V
C312	5322 122 34098	Cap. chip	3.3 ±0.25 pF	100 V
C313	4822 122 30027	Cap. ceramic	1 nF ±10%	100 V
C314, 315	5322 122 34098	Cap. chip	10 nF	50 V
C317	5322 124 10455	Cap. tantal	68 µF	6,3 V
C318	4822 122 31414	Cap. ceramic	10 nF	100 V
C319	5322 122 34098	Cap. chip	10 nF	50 V
C320	4822 122 31414	Cap. ceramic	10 nF	100 V
GR301	5322 130 34877	Diode	1N6263	
GR302, 303	5322 130 34364	Diode	BA379	
GR304	5322 130 34283	Diode	HP5082-2835	
GR306, 307	5322 130 34283	Diode	HP5082-2835	
IC301	5322 209 82858	IC	SAB1009BP	
IC302	5322 209 86199	IC	SAB1046	
IC303	5322 209 86201	IC	3140E	
L301	5322 158 10311	COIL		
L303	5322 158 10052	COIL		
R301	5322 116 54392	Res. metal film	100 ohm 5%	2.5 W
R302	5322 116 54396	Res. metal film	468 ohm 5%	2.5 W
R303	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R304, 305	4822 111 30605	Res. carbon	56 ohm 5%	0.2 W
R306	4822 111 30069	Res. carbon	39 ohm 5%	0.2 W
R307	4822 111 30324	Res. carbon	100 ohm 5%	0.2 W
R308	4822 111 30745	Res. carbon	33 ohm 5%	0.2 W
R309	4822 111 30352	Res. carbon	82 ohm 5%	0.2 W
R310	4822 111 30745	Res. carbon	33 ohm 5%	0.2 W
R311	4822 111 30327	Res. carbon	220 ohm 5%	0.2 W
R312...314	4822 111 30324	Res. carbon	100 ohm 5%	0.2 W

PRESCALER UNIT

Pos. No.	Order No.	Description		
R315	4822 116 51268	Res. metal film	100 kohm 0.5%	0.4 W
R316	5322 116 50557	Res. metal film	46.4 kohm 1%	0.4 W
R317	5322 101 14254	Potm. trimmer cerm.	10 kohm lin	0.5 W
R318	4822 116 51252	Res. metal film	6.81 kohm 0.5%	0.4 W
R319	5322 116 55268	Res. metal film	316 kohm 1%	0.4 W
R320	5322 116 50484	Res. metal film	4.64 kohm 1%	0.4 W
R321	5322 116 50767	Res. metal film	2.15 kohm 1%	0.4 W
R322	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
TS301	5322 130 44909	Transistor,	BFR90/02	
TS302, 303	4822 130 40937	Transistor,	BC548B	

TRIGGER INDICATOR UNIT

Pos. No.	Order No.	Description		
BU401	5322 267 50334	Connector	10 pole	
C401	5322 124 10455	Cap. tantal	68 µF	6.3 V
C402, 403	4822 122 31414	Cap. ceramic	10 nF	100 V
C404, 405	5322 124 10455	Cap. tantal	68 µF	6.3 V
C406, 407	4822 122 31414	Cap. ceramic	10 nF	100 V
GR401, 402	5322 130 30613	Diode BAW62		
IC401	5322 209 84825	IC	10216P	
R401...404	4822 116 51235	Res. metal film	1 kohm 0.5%	0.4 W
R405, 406	5322 116 50536	Res. metal film	464 ohm 1%	0.4 W
R407, 408	4822 116 51253	Res. metal film	10 kohm 0.5%	0.4 W
R409, 410	4822 116 51231	Res. metal film	562 ohm 0.5%	0.4 W
R410	4822 116 51231	Res. metal film	562 ohm 0.5%	0.4 W
TS401, 402	5322 130 44845	Transistor,	2N5771	

PANEL MOUNTED COMPONENTS

Pos. No.	Order No.	Description		
BU1	5322 267 10004	Plug, coax. female		
BU5...7	5322 267 10004	Plug, coax. female		
BU8	5322 268 10147	Connector for external battery		
BU9	5322 265 30066	Line inlet socket		
C6, 7	5322 122 40444	Cap. ceramic	1 nF	250 V
GR1	5322 130 31502	LED	yellow	3 mm
L5, 6	5322 121 44235	COIL	40 µH	
R1/SK1		See list for basic unit.		
R5	5322 101 54909	Res. metal film	1 kohm 5%	1.6 W
SK5	5322 272 10217	Mains voltage selector		

MECHANICAL PARTS

Pos. No.	Order No.	Description
	5322 414 34091	Knob 10 mm, grey.
	5322 414 30044	Knob 10 mm, brown.
	5322 414 74015	Cap for knob 10 mm, light grey.
	5322 414 70015	Cap for knob 10 mm, brown.
	5322 414 34076	Knob 18.7 mm, grey.
	5322 414 30038	Knob 18.7 mm, brown.
	5322 414 74019	Cap for knob 18.7 mm, light grey.
	5322 414 70016	Cap for knob 18.7 mm, brown.
	5322 414 20033	Button, push brown.
	5322 414 64053	Button, push grey.
	5322 414 25851	Button, push grey-green.
	5322 414 20034	Button, push brown-green.
	5322 414 26019	Button, push light grey (for POWER ON).
	5322 414 20035	Button, push dark brown (for POWER ON).
	5322 447 90499	Front panel.
	5322 447 90508	Text plate brown, front PM6670.
	5322 447 90509	Text plate brown, front PM6671.
	5322 447 90511	Text plate brown, front PM6672.
	5322 466 91587	Window.
	5322 447 90514	Rear panel, PM6670.
	5322 447 90515	Rear panel, PM6671, 72.
	5322 466 85335	Front rim.
	5322 459 24054	Rear rim.
	5322 498 50127	Handle.
	5322 528 34101	Lock washer for handle.
	5322 520 34164	Bushing, bearing for handle.
	5322 530 84075	Spring washer for handle.
	5322 414 64053	Knob for handle, grey.
	5322 414 30043	Knob for handle, brown.
	5322 462 44179	Foot, bottom.
	5322 462 44431	Rubber-foot (for 5322 462 44179).
	5322 462 44181	Foot, rear panel.
	5322 447 90006	Top cover, grey.
	5322 447 90512	Top cover, brown.
	5322 447 90007	Bottom cover, grey.
	5322 447 90513	Bottom cover, brown.
	5322 447 84642	Protective front cover, grey.
	5322 447 90498	Protective front cover, brown.
	5322 466 60835	Side profile.
	5322 267 30501	Connector Mini coax for PCB mounting.

MECHANICAL PARTS

Pos. No.	Order No.	Description
	5322 321 20504	Cable assy for C-channel.
	5322 321 20505	Cable assy for A and B channels.
	5322 255 40428	IC socket, for 16-pin.
	5322 255 40429	IC socket, for 18-pin.
	5322 255 40431	IC socket, for 28-pin.
	5322 255 40422	IC socket, for 40-pin.
	5322 255 40274	Heatsink for GR183.
	5322 255 40427	Heatsink for IC181 (PM 6670 only).
	5322 467 34127	Guide rail for PCB.

9. OPTIONAL OSCILLATORS

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PM 9679E, PM 9690 and PM 9691
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9. OPTIONAL OSCILLATORS

Technical specification

	02 version PM 9678B	03 version PM 9679E	04 version PM 9690	05 version PM 9691
Nominal frequency	10MHz	10MHz	10MHz	10MHz
Trimming range (1	>±20Hz	-100...+40Hz	-7...+3Hz	-7...+3Hz
Output voltage into 1 kohm	$>100mV_{RMS}$	$>1V_{RMS}$	$>150mV_{RMS}$	$>150mV_{RMS}$
Supply voltage, DC	+11.5...28V	+11.5...28V	+11.5...28V	+11.5...28V
Power consumption (+23°C)				
- Continuous operation	<15mA (2	<100mA (3	<125mA (2	<125mA (2
- Stand-by	none	<100mA (3	<125mA (2	<125mA (2
- Warm-up	none	<400mA	<400mA	<400mA
Stability against:				
- Ageing /24h	NA	NA	$<1.5x10^{-9}$ (4	$<5x10^{-10}$ (4
/month	$<1x10^{-7}$	$<1x10^{-7}$	$<3x10^{-8}$	$<1x10^{-8}$
/year	$<5x10^{-7}$	$<5x10^{-7}$	$<1.5x10^{-7}$	$<7.5x10^{-8}$
- Temperature 0...50°C ref. to 23°C	$<1x10^{-6}$	$<1x10^{-7}$	$<3x10^{-8}$	$<5x10^{-9}$
- Line voltage ±10%	$<1x10^{-9}$	$<1x10^{-9}$	$<5x10^{-10}$	$<5x10^{-10}$
- Change of measuring mode and change between line and ext/int battery	$<5x10^{-8}$	$<1x10^{-8}$	$<3x10^{-9}$	$<3x19^{-9}$
Warm-up time to reach $1x10^{-7}$	NA	<10 min	<15 min	<15 min
Dimensions	93x50x15mm	100x52x35mm	100x52x35mm	100x52x35mm
Weight	25g	100g	100g	100g
Environmental conditions	All oscillators meet the same specifications as the PM 6670 series of counters.			

(1 The trimming range will cover at least 10 years of operation since the ageing will decrease substantially after the first 6 months. For PM 9690 and PM 9691 the indicated values apply only to the fine trimming range. However, a coarse trimmer is available.

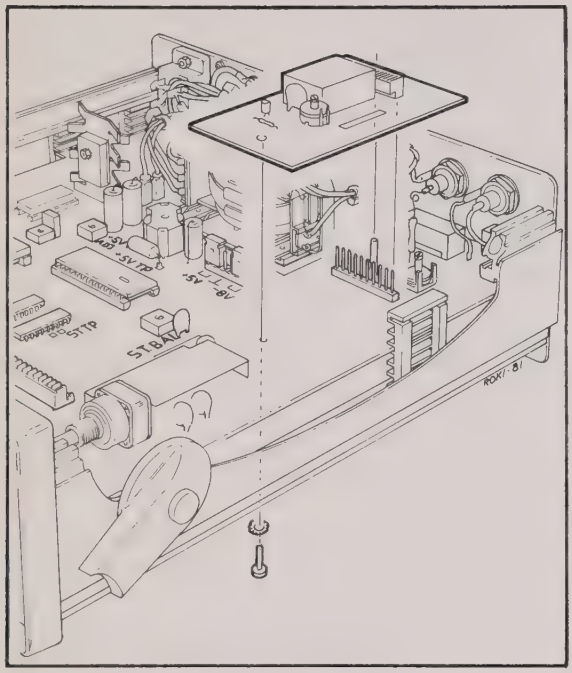
(2 At 11.5...28V

(3 At 11.5V. Less than 60mA at 28V

(4 After 48 hours of continuous operation.

Installation of PM 9678B

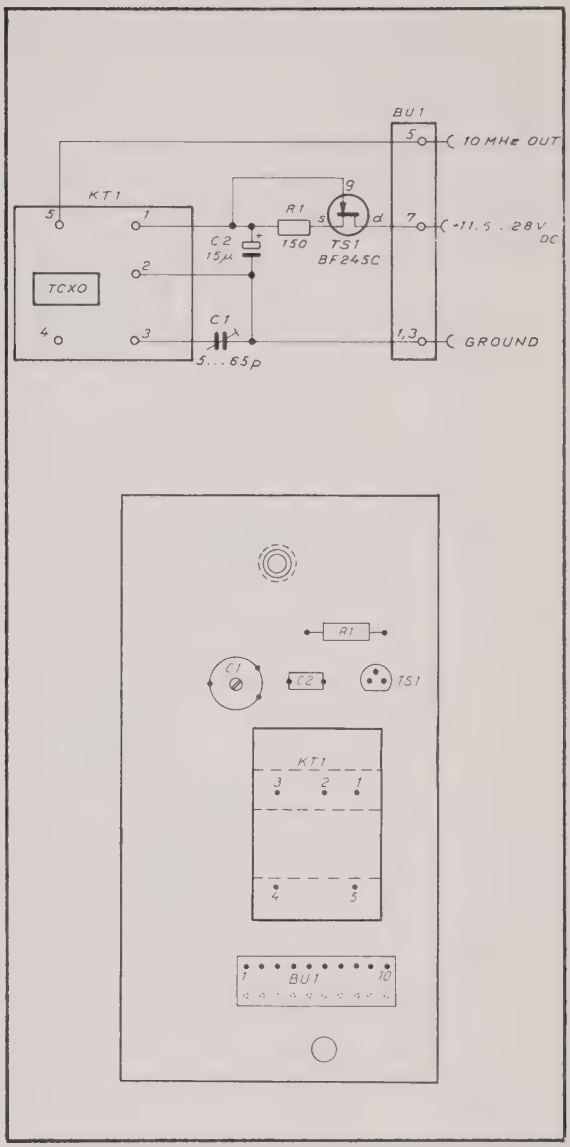
Remove the x-tal KT151 before installing the oscillator PM 9678B.



Frequency adjustment of PM 9678B

This adjustment requires a reference oscillator with an accuracy of $< 1 \times 10^{-7}$. Philips oven enclosed oscillators PM 9680, PM 9681, PM 9690 and PM 9691 meet this requirement, if calibrated. The adjustment should preferably be made at an ambient temperature of +23°C.

- Connect the reference signal to Input A of the counter to be adjusted.
- Set the measuring time to 1s and press the ⎍ pushbutton.
- Adjust trimming capacitor C1 on the oscillator board until the display read-out is:
  10000.000kHz ± 1Hz.
- Set the measuring time to 10s and check that the display read-out is the same as before. If not, adjust C1 slightly to obtain the correct read-out.



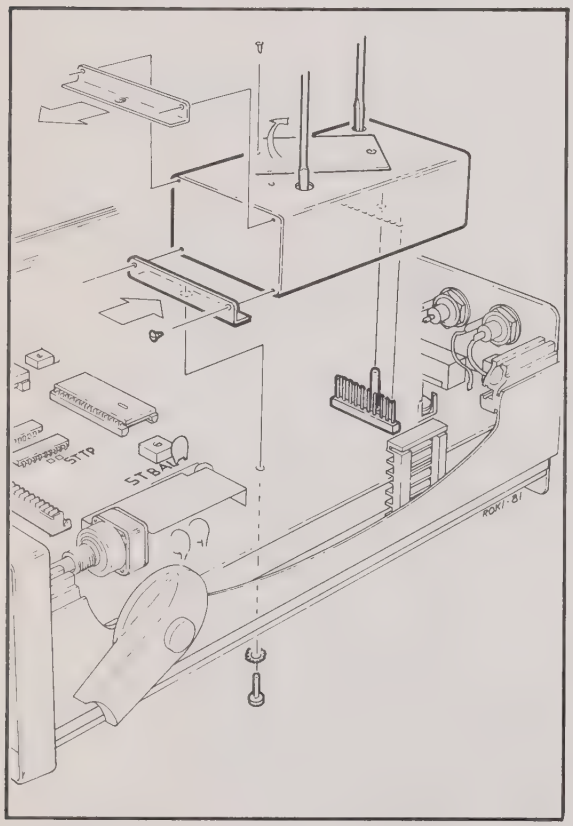
Spare parts list

Order number	Description	Specification	Item
5322 267 50336	Connector	10 poles	BU1
4822 125 50017	Cap, Trim.	5.5-65pF 100V	C1
4822 124 20977	Cap, Elec.	15uF 16V	C2
5322 216 94047	Osc, TCXO	10MHz	KT1
4822 110 63085	Res, Carbon	150E 5% 0.33W	R1
4822 130 41065	Trans, FET	BF245C	TS1

Installation of PM 9679E, PM 9690 and PM 9691

Remove the x-tal KT151 before installing the optional oscillator. Only the bracket with the rivet nut should be mounted on the oscillator.

Note: Before installing an older version of these oven enclosed oscillators, measure if pole 1 and 2 of the oscillator are short circuit. If so, cut pin 1 and 2 on BU103 in the counter.



Frequency adjustment of PM 9679E

This adjustment requires a reference oscillator with an accuracy of $< 3 \times 10^{-8}$. Philips oven enclosed oscillators PM 9680, PM 9681, PM 9690 and PM 9691 meet this requirement, if calibrated. The adjustment should preferably be made at an ambient temperature of 23°C and the oscillator must have been operating continuously for 48 hours before any adjustment is made. An isolated trimming screw driver is also neccessary.

- Connect the reference signal to EXT TRIGG of a 50MHz oscilloscope, e.g. Philips PM 3215.
- Connect the oscillator signal available at socket INT STD OUT of the counter to be adjusted, to Input Y of the oscilloscope.
- Set the oscilloscope to 100ns/div and adjust the trimmer until the waveform moves with a velocity of max 1div/3s (0.3Hz).

Frequency adjustment of PM 9690 and PM 9691

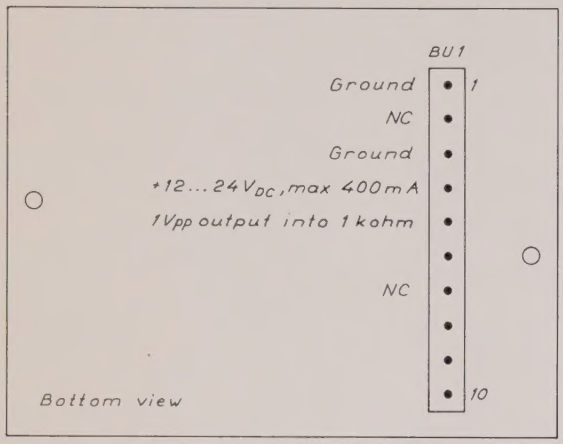
This adjustment requires a reference oscillator with an accuracy of $< 1 \times 10^{-9}$. Hewlett-Packard quartz frequency standard HP105 meets this requirement, if calibrated. The adjustment should preferably be made at an ambient temperature of 23°C and the oscillator must have been operating continuously for 48 hours before any adjustment is made. An isolated trimming screw driver is also neccessary.

- Connect any of the three reference signals available at sockets 5MHz, 1MHz and 100kHz of the HP105 to EXT TRIGG of a 50MHz oscilloscope, e.g. Philips PM 3215.
- Connect the oscillator signal available at socket INT STD OUT of the counter to be adjusted, to Input Y of the oscilloscope.
- Set the oscilloscope to 100ns/div and adjust the fine trimmer in the oscillator until the waveform moves with a velocity of max 1div/10s (0.1Hz).

If the adjustment range is too narrow, proceed as follows:

- Set the fine trimmer fully clockwise.
- Remove the two screws fixing the oscillator's text plate to the unit.
- Remove the small plastic cylinder beneath the text plate using a pair of tweezers.
- Connect an external counter via a 10Mohm probe to socket INT STD OUT of the counter to be adjusted.
- Adjust the coarse trimmer until the display read-out of the external counter is:
  10000003Hz.
- Refit the plastic cylinder and the text plate.
- Recheck that the waveform velocity is 1div/10s, see above.

Pinning of PM 9679E, PM 9690 and PM 9691



Note: Pin 6, 8, 9 and 10 are for factory use only

Repair of oscillator PM 9679E, PM 9690 and PM 9691

Repair of these oscillators may not be carried out by the local service organization. The complete sealed oscillator unit has to be sent to the factory for repair.

Factory address:

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Casilla 343, Quito; tel. 593-2-239080 (service)

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